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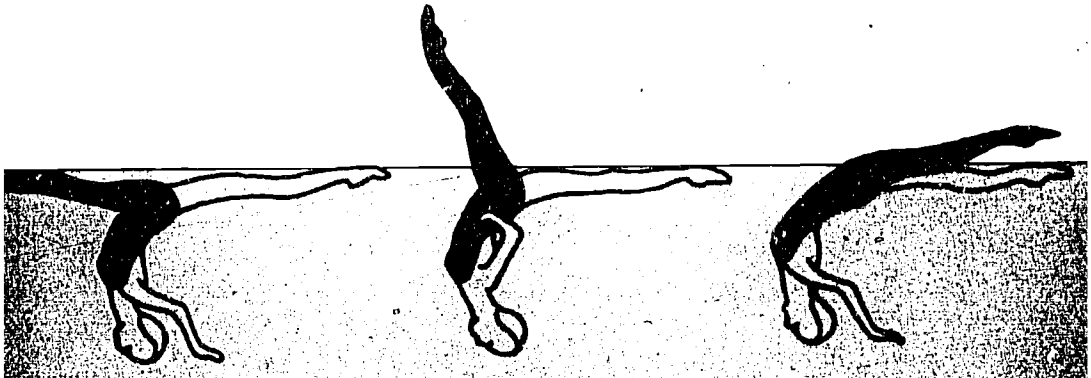
ABSTRACT

This collection of articles contains information about synchronized swimming. Topics covered include general physiology and cardiovascular conditioning, flexibility exercises, body composition, strength training, nutrition, coach-athlete relationships, coping with competition stress and performance anxiety, and eye care. Chapters are included on common orthopedic problems affecting synchronized swimmers. The psychological aspects of elite women synchronized swimmers are also discussed. A comprehensive study of the anatomy of the shoulders and knees of synchronized swimmers is appended. The writings reflect the current trend in sports medicine to go beyond the concept of a team physician who cares for the injured athlete: rather, the emphasis is on the total physical and psychological health and well-being of the athlete. (JD)

SPORTS MEDICINE MEETS SYNCHRONIZED SWIMMING



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INTRODUCTION

Sports medicine today goes well beyond the concept of a team physician who cares for the injured athlete. It is developing into a cooperative multidisciplinary effort incorporating the theory, knowledge and skills from the various medical fields, exercise physiology, physical education, biomechanics, nutrition and the behavioral sciences. The emphasis is shifting to the total physical and psychosocial health, development and well-being of the athlete who from an early age to late adulthood participates in both competitive and recreational activities.

Sports medicine materials available to synchronized swimming have primarily come from Physician and Sportsmedicine and Swimming World on such topics as physical conditioning and ear, eye, knee and shoulder problems. Very little data and information specific to synchronized swimmers has been collected until 1977. It was at this time that the AAU National Synchronized Swimming Committee established a comprehensive and organized training program for coaches and athletes at the new United States Olympic Training Centers. Much of the collected information and data is made available in this book through the cooperative efforts of NAGWS, the AIAW Synchro Coaches Academy and the AAU Synchro Sports Medicine Committee.

You will find contained in this book, information on general physiology and cardiovascular conditioning, flexibility exercises, body composition, strength training, nutrition, coach-athlete interpersonal relationships, coping with competition stress and performance anxiety, eye care and other topics of interest to coaches and athletes. Many of the articles are useful for those working with younger athletes as well as international level competitors. Some of the more technical articles may be difficult to understand, depending on the reader's background and interest. Nonetheless, the decision was made to include them as reference material. For example, specific shoulder and knee anatomy may be of interest only after injury occurs, whereas the chapter on general injury care may have wider interests and application. The same may be said for the chapter

on general physiology versus the chapters on conditioning techniques. The reader is also encouraged to review the reading lists in areas of particular interest.

The contents are by no means a comprehensive compendium of sports medicine. The most glaring omissions include ear problems (see Physician and Sportsmedicine, Swimmers World or your own physician), sociological aspects of sports and biomechanics. There is abundant information on the biomechanics of synchronized swimming figures available in the following recent sources:

Jones, F.L. & Lindeman J. The Components of Synchronized Swimming. NJ: Prentice Hall.

Jones, F.L. & Lindeman J. Champions on Film. Ann Arbor: University of Michigan.

Lundholm, J. & Ruggieri, M.J. Introduction to Synchronized Swimming. Minn.: Burgess.

Synchro Magazine. 11902 Red Hill Avenue, Santa Ana, CA 92705. (Ross Bean has an ongoing series of figure skill analysis, coaching tips and judging aspects.)

My thanks go to C. Harmon Brown, MD. FACSM (Chair of women's track and field development and former olympic coach) who serves as the medical advisor for AAU Synchro, Kathy Kretschmer (San Francisco Merionnette Assistant Cocach, former world champion and representative to the Athletes Advisory Council of the US Olympic Committee) and Dale Waddell (former coach of the Hayward Area Recreation District Flying Fins) who read the manuscripts for both content and readability. Topper Hagerman, PhD (head of the exercise physiology lab at the US Olympic Training Center Squaw Valley), provided the design and means for much of the physical data collection, as did the Work Physiology Lab at Ohio State University. Without all of their dedicated efforts and helpful feedback, this publication would be less valuable. Special thanks and

gratitude must go to Dale Waddell who volunteered and contributed her time and energy to the onerous task of typing this book. Lastly, and certainly not least, our thanks go to NAGWS who provided the funds and support for the publication of this manual.

This book is dedicated to the athletes and coaches who make synchronized swimming the magnificent sport that it is.

Betty J. Wenz

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Not too many years ago it was unheard of to become a competitive synchronized swimmer and afford. Even at least one basic stroke you could join a pool or club and start swimming. If it were a "Y" pool or a large club you might find a coach who could work with you on your technique and suggest some kind of schedule for your training which you would follow or not at your convenience. If you went to a high school or a college with a synchronized swimming team the chances are you would have better coaching and more regular practice. There were relatively few meets during the indoor season, which typically from November to May, and even fewer in the outdoor season, which was summer vacation and most people didn't train very seriously during that time.

A serious commitment to synchronized swimming today means a willingness to be involved in training all year around, often in twice a day sessions, a long competitive season, strict dietary control, and in general restructuring an athlete's life, and often that of the family, around the demands of the sport. What has brought about these changes? A number of social factors are involved including the growing importance of sport as a means of expression and communication between countries as well as individuals, more time and money available for recreational pursuits, and a more general appreciation of sport as means to developing personal physical fitness. The driving force behind the ways in which we practice sports today, however, comes from the development of sports medicine.

Sports medicine is much more than an area of interest for physicians who enjoy working with athletes. It enlists the interests and services of people from a wide variety of special fields including physical education, exercise physiology, biomechanics, kinesiology, physical therapy, athletic training, sport psychology, sport sociology and sport history. It is comprised of four particular areas: the medical and paramedical supervision of the recreational and competitive athlete;

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We have identified the basic qualities which make for effective performance in sport: strength, speed, endurance, agility, balance, coordination, flexibility, quick reaction, and high capacities in the respiratory and cardiovascular systems. We have shown that improvement in these qualities come about only as the result of overloading the systems from which they are generated and doing this regularly and consistently over time. We know that the integration of these qualities in the individual makes possible the practice of a sports skill and that through repetition the skill becomes registered as a neuromuscular pattern which as the result of practice becomes automatic and reproducible. We have learned that these effects of training can be maintained only by repetition at an average frequency of three times weekly.

Experiment and experience have demonstrated that there are different methods of developing strength and endurance, that each has certain advantages and disadvantages, and that there are substantial differences in individual responses to these methods based on age, genetic endowment, sex, and attitudinal factors.

Sports medicine has taught us to distinguish

between aerobic and anaerobic forms of exercise and explained how muscles convert the foods that we eat into energy, showing that carbohydrates and fats are the sources of this energy when processed through several complex chains of chemical reactions. Training schedules can thus be established based on a more precise knowledge of an individual's maximum capacities and the time necessary to recovery from particular exercise loads. We know that the use of drugs and vitamins are not the means toward successful sports performance so that we can refute the claims of the hucksters who tell us that they are.

The psychology of practice and competition has been extensively explored and described in a voluminous literature. National teams now have team psychologists who work with groups and individuals to help them understand their motivations toward sport and to overcome the problems and frustrations which may prevent them from reaching their goals. Experience has shown that it is equally important for the psychologists to work with the coaches as well as the athletes.

Some of the most remarkable contributions of sports science have been in understanding the problems posed to the athletes by their environment. We know how the human body reacts to high ambient air temperature and humidity, to extreme cold and high wind velocity, to low barometric pressure at altitude and to increased pressure in underwater activities and we know the counter measures that can be taken and how to treat the injuries and illness that occur when these measures are not taken or prove to be ineffective.

Because injuries are inevitable concomitants of sports, physicians have been provided with an enormous volume of externally caused traumas and internally generated overuse injuries to manage by surgical and non-surgical means. As the result of this experience techniques of treatment have been developed which now return the majority of injured athletes to their sports, ordinarily without residual disability. The demands of sport which require

that function be restored to normal, or as close to that as possible, have forced the development of procedures which are now applied regularly to non-athletes as well.

Synchronized swimming as a recreational activity has been applied only minimally so far to the uses of handicapped persons, as a means of developing individual physical fitness, and to the purpose of rehabilitating the convalescent ill and injured through a pleasant, expressive, rhythmical exercise program. This still awaits a more general knowledge of the sport, and a greater availability of time in existing pools, experienced instructors and funds for programs. Future growth in theses areas will emphasize the important interaction between this sport and the entire field of sports medicine.

WORK (EXERCISE) PHYSIOLOGY: USEFUL CONCEPTS FOR PHYSICAL FITNESS

Donald F. Kirkendall, PhD

When the synchronized swimmer takes her place at the start of a competition, her training ideally has prepared her for all aspects of that competition. She must have achieved a level of skill in her techniques and a level of physical fitness necessary to carry out her routine. Upper and lower body strength, sufficient conditioning, significant body flexibility and physical power are but a few of the components of fitness that the synchronized swimmer must contend with in her training. When comparing performances, the athlete who usually succeeds is the one who can sustain performance at a higher and more intense physical work level and, if performing at a submaximal level, can perform more efficiently.

All coaches are concerned with the conditioning of athletes under their charge, for without physical fitness, performance rapidly declines. It is helpful to both coaches and most athletes to have an understanding of work (exercise) physiology and how it applies to physical conditioning and performance. Work physiology is that special area of human physiology that examines the effect of physical stress (exercise; athletic performance) on physiological function. In this section you will be introduced to the major concepts involved, and subsequent authors will provide some useful information and programs specific to the training of synchronized swimmers.

We can classify any exercise on a basis of the interplay of 3 factors; resistance (amount of force the body must produce to overcome resistance), speed/power (the rate at which a movement is performed; power = work per unit of time), and duration (length of time the activity is to be performed.) (Figure 1) It is advisable to orient yourself with the graph realizing that exercises located near the origin (intersection of the 3 axes) are the least strenuous and those farther out on any axis represent more strenuous activities, with the boundaries depicting maximal exercise. In the course of this and other sections, you may find it useful and

necessary to refer to this figure.

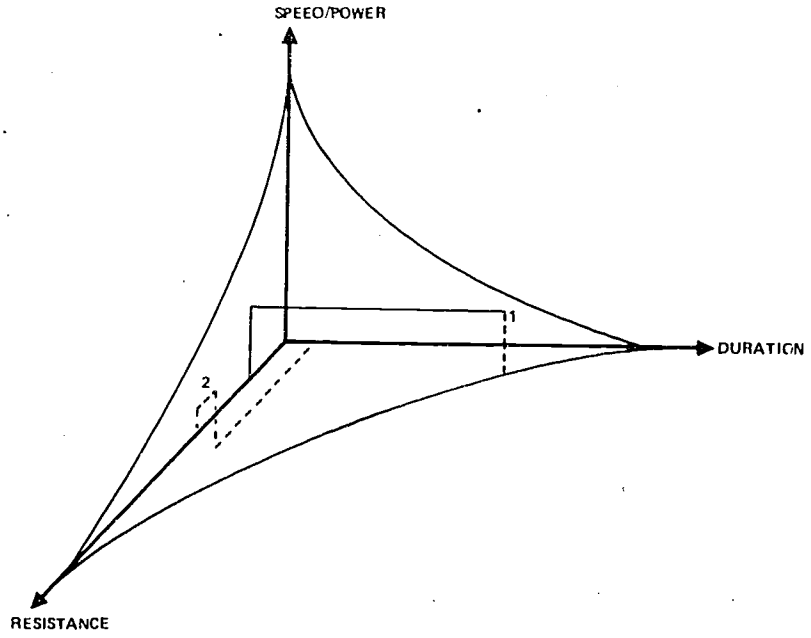

Figure 1 - INTERPLAY OF SPEED, RESISTANCE AND DURATION

1 = Distance running, 2 = Weight lifting

In order to perform physical work, it is necessary to provide the cells with a fuel. Nutritional aspects of performance will be dealt with more comprehensively in the section on nutrition*; however, as we ingest nutrients they are digested and absorbed by the stomach and intestines and affect physiology.

*Ed. note: see Porcello, pp. 66-88

Three foodstuffs are considered in exercise; fats, carbohydrates, and proteins. Fats are broken down to their component fatty acids and glycerol, reabsorbed in the intestine, first to the lymphatic system then to the blood stream and then adipose (fatty) tissue. Fats are stored until needed to fuel the muscles for exercise. Carbohydrates are broken down to simple sugars and reabsorbed, reassembled in the liver and muscles as glycogen after intestinal absorption and vascular transport. Proteins are reduced to their component amino acids, absorbed and transported to the cells to be used as building blocks of muscle and bone or as components of enzymes, hormones and buffers. Proteins generally add little as a fuel for exercise.

We perform work in one of 2 ways; aerobic, in the presence of oxygen, or anaerobic, without oxygen. The intensity and duration of the exercise dictate the system which supplies the major amount of energy. (Figure 2). In aerobic exercise, glycogen and fats

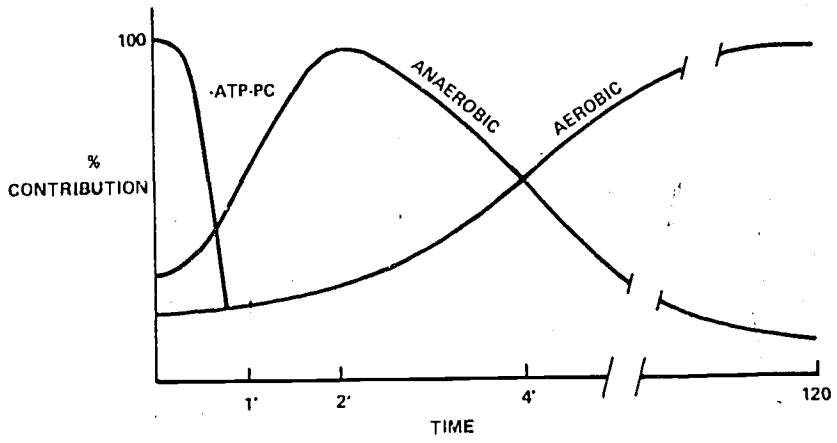

Figure 2 - PERCENT CONTRIBUTION OF THE RESPECTIVE METABOLIC PATHWAYS

supply the fuel and in the process are broken down to CO_2 and H_2O. The metabolism of these fuels produces a high energy compound (ATP) which contains energy stored within the chemical bonds of the molecule. When ATP is split, energy is liberated and work can be performed. In the process, CO_2 and H_2O are the subsequent end products. In anaerobic exercise a similar, if less efficient, process occurs except that the end product is an acid; lactic acid to be specific. Obviously, aerobic metabolism yields more easily eliminated waste products. And, considering the supply of fats in the body, can supply energy for extended periods of time. Anaerobic metabolism, on the other hand, has specific limits on how long it can keep supplying energy (less than 1 minute of sustained, maximal, totally anaerobic work in the absolute, theoretical state); however, it can supply energy very rapidly. Both systems operate in conjunction with each other and are never completely independent of the other.

So far we've seen the ingestion of nutrients, their storage as fuels and their being metabolized for work with or without oxygen. But how does the oxygen get to the cells to be used in metabolism? Oxygen is picked up from the lungs and attaches to a molecule in the red blood cell, hemoglobin, for the transport to the cells which are in need. The blood then passes to the left side of the heart and pumped to the body through arteries. They branch ever smaller until capillaries are observed. Capillaries, the smallest of vessels, are where the exchange of gases, nutrients, and waste products take place. Oxygen is passed to the tissues and CO_2 is picked up and transported through larger and larger vessels and eventually reaches the right side of the heart where it is pumped to the lungs to be excreted. This process must occur because the body has, for all intents and purposes, no real ability to store oxygen, and CO_2 buildup could cause chemical changes that are not compatible with performance.

COMPONENTS OF FITNESS

In considering the concept of "physical fitness," it must be clear that no one component best represents

the concept. The demands of the sport define the emphasis on the components necessary for successful performance. A marathon runner obviously needs a high degree of aerobic endurance when compared to a 100 meter sprinter while the reverse is true of a speed/power component. In considering fitness, we see a number of components of which the coach needs to be aware when designing a training program. Emphasis of the following elements will vary with respect to each sport. Reference is also made to the classification figure when visualizing some of the components.

Aerobic Capacity: This more than any other variable has been utilized as an excellent (best?) measure of fitness, more specifically, endurance. Two factors are contained within; i.e., the ability of the central cardiovascular system to transport oxygen to the working muscles and the ability of the working muscles to use the oxygen delivered. When the body is at rest, it is in what is referred to as a steady state; i.e., the energy demands of the body are being met by the oxygen supply. If work is to be done, with CO_2 and H_2O as the desired waste products, a new, higher steady state is necessary. As more oxygen is needed to supply the working cells, it is necessary to breathe more often and more deeply. Also, the heart rate increases to move the oxygen rich arterial blood to the muscles faster. The body does not jump to this new, higher, working steady state; there is a period where anaerobic means supply the energy and this means some buildup of lactic acid. This lactate buildup is not usually decreased until the end of the exercise or during much less intense periods of exercise. To rid the body of lactate, oxygen is consumed and lactate proceeds through aerobic metabolism to CO_2 and H_2O. Thus, the reason behind extended heavy breathing following exercise, to partially rid the body of lactate accumulated when adjusting to changes in work intensity during the exercise. Activities which train the aerobic system are those of low speed and resistance and high duration; e.g., running, swimming, bicycling, rowing, cross-country skiing. Most people in the field advise that about

20-30 minutes of continuous exercise 3 day/week is the minimum needed to place an adequate training stimulus on the aerobic system. Field tests of aerobic power are available. Two of the better tests include the 12 minute run (total distance covered in 12 minutes) and 1.5 mile run for time (average values for women are about 1.25 miles and 15:00 respectively). The more aerobically fit athlete will run farther in 12 minutes or faster for the 1.5 mile run. At present, a similar swimming task has not been validated. However, following the 1:4 conversion (energy to 1/4 mile swimming = 1 mile running) might give a, as yet unvalidated, statement about aerobic swimming capacity.

Anaerobic Capacity: This aspect entails the ability to perform explosive activities of short duration. While it is the least understood of the components, a couple of things are known. There are 2 factors here also, a power component for maximal, intense short term activities (less than 10 sec, the ATP-PC system) and another for slightly longer (less than 1 minute) intense activites. Research indicates that the former factor, needed for activities like weight lifting competitions, is trainable, i.e., we can increase the body's ability to turn over ATP for such requirements while it appears that the latter factor is not. This means that neither training program used in research has been intense enough to cause a change or the methods for quantifying changes are not discrete enough. Until we get more conclusive information, it appears that the body already contains sufficient capacity to perform explosive efforts lasting under 1 minute. Consult Figure 2 again. Remember that the energy systems are very closely integrated and that these time spans mentioned are determined in theoretical situations where only that one system is functioning. Therefore, it should be fairly clear that because we cannot separate these factors, it is very difficult to study. While this is true, it appears that resistive exercises (strength training), interval training and/or circuit training seem to have positive effects on performance tests that supposedly measure anaerobic power.

Strength: Strength is normally defined as the ability of the muscle to provide a maximal force with a single contraction. Strength increases can be trained by isometric ("same length"), isotonic ("same tension") or isokinetic ("same velocity") methods. All methods will increase strength, the basis of which appears to be a change in the size, not in the number of muscle fibers.

Development of strength over the range of motion of a limb is quite important. This means that strength should be developed at each angle of motion that the limb moves through. As a result, isometrics only strengthen the muscle at the angle at which it was trained. More traditional, isotonic, methods are better. Free weights, or machines (e.g., Universal or Nautilus) are isotonic means Proper execution of the movement will ensure that flexibility is not sacrified. Isokinetics (e.g., Cybex, Minigym) allow maximum force to be generated at all ranges of motion at controlled velocities. One added benefit of isokinetics is the reduced amount of soreness usually associated with strength training. While free weights appear to be the best method of increasing strength, for athletes new to lifting, the machines are probably the easiest and safest devices for strength training. Women should not shy away from training with weights because they are afraid of "bulking up." In order to add a great deal of muscle weight, the hormone testosterone is needed. As women produce little of this hormone, there are usually only slight increases in muscle mass. Yet, they will still increase strength. While men will show greater absolute gains in strength, if the same results are compared on the basis of non-fat weight (weight of the body minus the weight of fat) the women actually show greater gains. This may be partially due to the fact that women had little experience with strength training programs and, therefore, have more room for improvement. Details about weight programs can be found in sections on weight training* and circuit training.**

*Ed. note: see Ruggieri, pp. 113-124
**Ed. note: see Ruggieri & Raipa, pp. 107-112

Power: The power (the amount of work that can be done in a specific time span, i.e., force x distance ÷ time) component is one which has considerable interplay with the central nervous system and heredity. Production of power depends on the reception of the stimulus (e.g. hearing the starting gun), production of power (recruitment of the particular muscle fibers specific to high power output) and the amount of high power fibers that a person was born with. Power is quite specific to the sport, that is, power for the shot put does not necessarily transfer to the power needed for, say, soccer goalkeeping.

Flexibility: The range of mevement through which a joint moves is referred to as flexibility. This component is particularly important in synchronized swimmers. With little flexibility of the legs and hips, the proper execution of split positions can be quite difficult. It should be emphasized that flexibility appears to be specific to the joint and is not a general whole body trait. Detailed information about flexibility can be found in Burke's article on warm-up and flexibility.*

Basis of Fatigue

A major limitor of performance is not one easily defined or measured, but here are a number of variables which contribute to fatigue, which is most evidenced by a loss of motor skill; i.e., an inability to correctly execute a skill.

Lactic acid has been looked into extensively as a cause of fatigue. One of the problems with lactate is that it causes a change in the normal chemical balance (pH) of the system, and this change (decline) in the pH can hinder the ability of the cell to properly produce energy. It is possible that this culprit may be one of the major limitors of performance in synchronized swimmers. Psychological fatigue is a factor, but is not considered in this section.

In longer duration activities, like the marathon,

*Ed. note: see Burke, pp. 16-28

losses of muscle glycogen, body water (dehydration), increased body temperature and mineral losses* all contribute to the physiological aspect of fatigue. Due to the time element of the synchronized swimming routine and the nature of the sport (i.e., a water sport, therefore little chance of overheating because the water is helping to keep the swimmer cool), these sources probably contribute little to the feeling of fatigue perceived by the athlete.

The Specificity of Training Concept

It should be evident that a specific exercise causes specific changes in the cells and the body. Endurance exercise (low power and resistance and high duration, 1 in Figure 1) causes increases in the aerobic component while high strength exercise (high resistance, low power and duration, 2 in Figure 1) train for increases in factors associated with anaerobic fitness. No one method of training will increase the body's capability to perform at all the extremes in Figure 1. The muscles respond to specific types of overload. For example, running on level ground places different demands on the body than not only bicycling, but also uphill running as well. As a result, a training program needs to encompass the components as they are used within the sport. If a sport is by nature endurance oriented, then power and resistance are usually sacrificed, meaning that one rarely sees a distance runner lifting heavy weights nor do you often see a 100 meter sprinter putting in extended miles in preparation for his event. They train specifically for their event. This should not be construed as "playing your way into shape." Strength and flexibility training, for example, may be necessary as supplemental training methods for optimal performance. If the coach examines the performance critically, the need for stressing the required components becomes obvious. The adequate performance of many of the skills depends on outstanding flexibility. Some of the dynamic, explosive movements demand that a certain amount of power specific training be incorporated into the training regime while the aerobic fitness of the performer is

*Ed. note: see Porcello, pp. 66-88

of concern allowing the execution with minimal fatigue. Neither should the strength of the athlete be overlooked simply because of sex or nature of sport. It is, therefore, more advantageous to construct a training program that will be specific for the event as this will usually bring about the physiological preparation necessary for optimal performance. It is the purpose of this volume to supply some needed information to help you construct the best program possible for your personal situation.

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WARM-UP AND FLEXIBILITY AS PART OF TRAINING AND PERFORMANCE PREPARATION

Edmund R. Burke, PhD

This chapter is composed of information on such topics as (1) the effects of warm-up on performance and injury, (2) prevention and care of muscle soreness, and (3) the importance of flexibility and flexibility exercises.

WARM-UP

Many coaches wonder how important warm-up is and what form and length of time should be spent on warm-up prior to competition and training. There are a number of physiological reasons why warming-up should be beneficial. Besides an increase in the speed and force of muscle contraction, ventilation and oxygen transportation is increased, and so is blood circulation. With these, "second wind" is more easily achieved and the strain on muscles, tendons, and ligaments is decreased.

Astrand (1978) states warm-up would give the benefit of higher muscle temperatures during swimming and that the chemical processes used to produce energy will be increased. For every degree rise in body temperature metabolism within the muscle cell will rise approximately 13%. At the higher temperature, the exchange of oxygen from the blood (hemoglobin) to the muscle would be increased. Nerve transmission travels faster at higher temperatures and improves both the contractile force and contractile speed in the muscle. All of these as well as other factors have been shown to be affected by warm-up.

There are two types of warming-up: active and passive. The first type is most commonly used and can be subdivided into two subtypes: related and unrelated. Related refers to performing the specific skills of synchronized swimming such as figures, movement progressions, the routine itself, or free swimming. Unrelated warming-up usually consists of exercising the large muscles of the body in ways not related to synchronized swimming, such as calisthenics or flexibility exercises. Related warm-up

has the effect of raising body temperature and effecting the nervous system while unrelated works on primarily raising the body temperature. Passive heating by hot baths, hot showers, Turkish baths, diathermy, and massage have been found to have some effect on increasing performance. When possible (if a pool is available) active warm-up should be used, however, unrelated and passive warm-up will be of some use if no pool time is available before competition.

Warm-up should be intense enough to increase body temperature, but not so intense that it will cause fatigue. Obviously, the intensity and duration of warm-up must be adjusted to the individual swimmer. Better performance results when a 15-30 minute rather than a 5 minute warm-up is used.

There is also a psychological effect inherent in warm-up, since it helps the athlete to achieve a state of mental readiness. Warming-up through related exercises appears to improve coordination by developing the swimmer's kinesthetic awareness and will establish a neuromuscular pattern of performance. The warm-up should begin to taper off 10 to 15 minutes prior to competition and end 5 to 10 minutes before performance if possible. This will allow recovery from any slight fatigue without losing the effects of the warm-up. While active warm-up may be impracticable before final competition (because of bathing suit and make-up considerations) unrelated and passive warm-up should be used.

One of the real values of warm-up is in its use as a preventative measure. It has been shown by Start and Hines (1963) that adequate warm-up prevents strains, muscle tears, and muscle soreness that would probably occur if the swimmer went into full performance without it. Morehouse and Miller (1971) state that those muscles most often injured are the muscles which oppose the strong contracting muscles. When not prepared these opposing muscles relax slowly, thus restricting free movement. Thus it seems that muscle injury is indeed a real possibility when vigorous exercise is not preceeded by

proper warm-up.

In summary, the best available evidence justifies the following principles for warming up:

1. Warm-up should be hard enough to increase body temperature, but not so difficult as to cause fatigue.
2. Warm-up increases the speed and force of muscle contraction.
3. Warm-up is important for the prevention of muscle soreness and injury.
4. Warm-up brings on second wind more readily.
5. Whenever possible, a related warm-up is preferable so that a practice effect may be achieved at the same time.
6. If active, related warm-up is impossible, passive or unrelated warm-up can be used.

MUSCLE SORENESS

At one time or another, every synchronized swimmer experiences muscle soreness that can be attributed to such things as starting a weight training program, a sudden increase in aerobic swimming yardage or effort, or the addition of difficult figures. The pain usually sets in between eight and twenty-four hours after exercise and is normally gone in a few days.

One commonly held theory attributes the specific soreness to tissue damage, such as microscopic tearing of the muscle or connective tissue. This hypothesis was developed by Hough in 1902, but was neither proven by him nor anyone else since then.

Some authorities attribute muscle soreness to incomplete removal of muscle metabolites. Either the production is so great or blood flow is so reduced (or a combination of both) that there is an accumulation of substances that are toxic to the muscles and nerve endings. Such excessive fluid accumulation might account for swelling of the muscle, making nerve endings more sensitive. This form of muscle stiffness is the type which usually occurs

after several days of hard practice. As a result the muscle becomes swollen, shorter and thicker. A good warm-up or massage can help reduce this soreness.

Work by DeVries (1974) has led to the "muscle spasm theory" of delayed muscle soreness. The sequence of events may go as follows: 1. the synchronized swimmer works out hard; 2. there is temporary lack of blood flow to the muscles; 3. this ischemia (lack of blood flow) causes pain in the nerve endings, probably activated by the release of a "P substance" across the muscle membrane into the tissue fluid; 4. the pain initiates a reflex toxic muscle contraction (spasm); 5. the spasm prolongs ischemia and the circle is complete.

Much of DeVries research leads to the use of static stretching to reduce soreness. Electromyographic equipment (which records electrical activity of the muscles), showed less activity in muscles after the use of static stretching. Symptomatic relief seems to parallel lower electromyographic values.

Recently work by Abraham (1977) has given support to the concept that exercise induced soreness may be related to the disruption of connective tissue in the muscle and/or to their attachments. Tremendous stress is placed upon the synchronized swimmer's muscles and tendons performing eccentric contractions during a routine or while lowering a heavy weight. In contrast, during concentric (isotonic,isokenitic) contractions, only the connective tissues associated with the tendons are stretched. The tension developed during eccentric contractions is, after all, greater than that possible during other types of contractions, and this has a greater effect on the swimmers connective tissue causing muscle soreness.

What does DeVries and Abraham's research mean to synchronized swimmers? By following a sound program of warm-up and stretching, the swimmers may have a certain degree of control over muscle soreness.

To train the swimmer properly and avoid undue soreness, the coach must stress the athlete's body to the correct degree and then allow it to recover. A progressive program calls for the continual adjustment of the difficulty and intensity of the workouts. When the swimmer is in top shape, adding something new such as weight work, hard intervals, or difficult figures should be done gradually.

FLEXIBILITY

Klafs and Arnheim (1977) consider flexibility, or the ability to move freely in various directions, one of the most important objectives in conditioning their athletes. Good flexibility will increase the synchronized swimmers ability to avoid injury. Since it permits a greater range of movement within the joint, ligaments, and muscles these tissues are not so easily strained or torn. It also permits her a greater range of movement in all directions. There definitely appears to be a relationship between injury and joint flexibility. The "tight" synchronized swimmer performs under a considerable handicap in terms of movement, besides being much more injury prone. Stretching also provides an excellent form of active unrelated warm-up.

The range of motion, measured in degrees, around a joint or group of joints is referred to as flexibility. For example, the flexibility of the elbow joint is the range of movement from full extension to complete flexion. A synchronized swimmer's ability to perform a swordalina rotation is dependent upon the flexibility around several joints including the knees, hips, and spinal column.

Three factors limit flexibility. The first, the bony structures of the joint, cannot be affected by stretching exercises. In some joints the body structures are the predominant limiting factor. The elbow and knee joints are examples. Second, the amount of bulk surrounding the joint. An example is the restriction of elbow flexion by the mass of the biceps muscle. At most joints, however, the third factor predominates. This factor is the degree of

extensibility of soft tissue around the joint. These soft tissues include the ligaments, tendons, and muscles. Stretching of the soft tissues through flexibility exercise gradually increases the distance they can be lengthened, thereby improving the range of motion. The shoulders and hips are excellent examples of joints where flexibility is only slightly limited by the bony structures and can be greatly increased through stretching exercises. Interestingly enough, a high degree of flexibility in one joint does not necessarily indicate a similar level in another joint. The "flexible" athlete must work on all joints of the body.

Some interesting aspects of flexibility are that it can be systematically improved; it is not a difficult component of fitness to modify. Considering these facts for such reasons as enhanced skill execution, possible injury prevention - it would appear that fifteen to thirty minutes of stretching would be a valuable addition to a training program.

Two forms of exercise have been used to stretch muscles and connective tissues, ballistic and static stretching. The first method of ballistic stretching puts the body part into motion and carries it through the range of motion until the muscles are stretched to their limits. Unfortunately, actions of this kind elicit a reflex in the opposing muscles (antagonist muscles) which limit the range of motion. Static stretching involves placing the muscles at their greatest possible length and holding that position for a period of time. Reaching down to touch the toes with the knees straight and then maintaining that position for approximately 30 seconds is a static flexibility exercise.

Both methods are effective in developing flexibility, but there are a greater number of advantages associated with the static method. There is less likelihood of overstretching and injuring a muscle. Static stretching seems to relieve muscle soreness, while the ballistic method may cause soreness.

Hatha yoga is also an excellent means of approaching static stretching. The Hatha yoga approach is slow, smooth, and coordinated; movements flow to rhythmically controlled breathing. Although some of the positions in yoga appear passive or relaxed, they are actually positive and dynamic. Slowly stretching muscles to full length and then holding them in absolute stillness causes blood to circulate evenly throughout the body. This allows the range of motion to be increased in all muscles, ligaments, tendons, and joints. Special emphasis is placed on increasing or renewing spinal flexibility by stretching. Each pose is a means to feel inwardly and discover your own areas of strength, flexibility, and energy. If you are already stretching regularly, yoga can enhance the effects by giving you a focus.

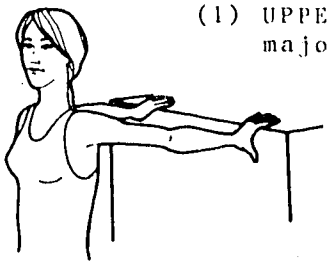
Before portraying some static and yoga stretching exercises, let's review some of the basic principles:

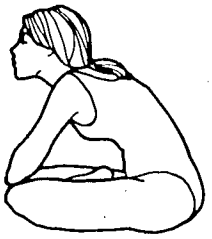
1. Flexibility can be limited by bone structure or by soft tissues. When it is limited by the soft tissues, great improvements can be brought about by the proper stretching methods.
2. Stretching by jerking or bouncing methods invokes the stretch reflex, which actually opposes the desired stretching.
3. Static and yoga stretching is safer than ballistic methods because it does not impose sudden strains upon the tissue involved.
4. Stretching provides an excellent form of active unrelated warm-up.
5. The basic guidelines are as follows:
   - A. Teach the athlete to stretch within their limits, without straining. When they begin the stretch, the first 20 to 30 seconds are spent in an easy stretch, they should be relaxed. Next, have them go a little further so the stretch becomes more intense but it should not cause actual pain. Straining will keep them from relaxing, both mentally and physically.

B. Do not let them hold their breath while stretching. This will only cause tension and detract from the relaxed state.
C. Stretching is not a contest, the athletes should not compare themselves.
D. Variety is the key, so why not create three or four different programs.

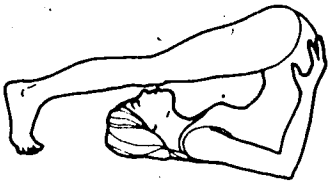
Below are a series of stretching exercises which can be used in a routine. The books listed in the references by Anderson and Luby also contain many more to expand your program.

(1) UPPER CHEST - Pectoralis major and minor



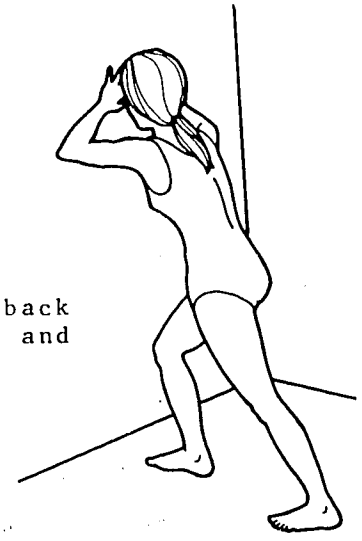


(2) YOGA - Leg abductors



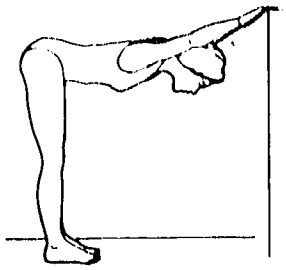
(3) "J" STRETCH - Works on lower back, buttocks, and back of legs

(4) "GASTRO" STRETCH - back of legs, hamstrings and gastrocnemus



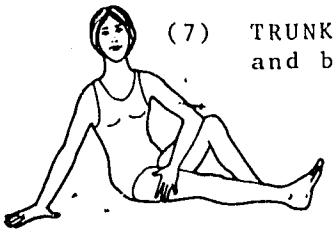
(5)

TOE POINTER - for front of feet, ankles and thighs

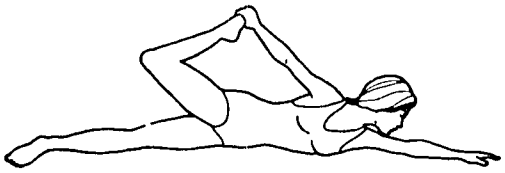


(6)

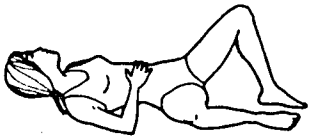
SHOULDER & UPPER BACK - excellent for upper back and shoulders



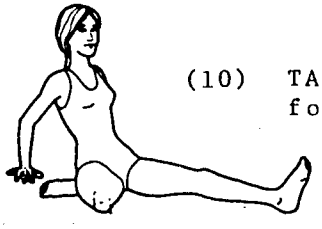
(7) TRUNK TWISTER - hip and back muscles



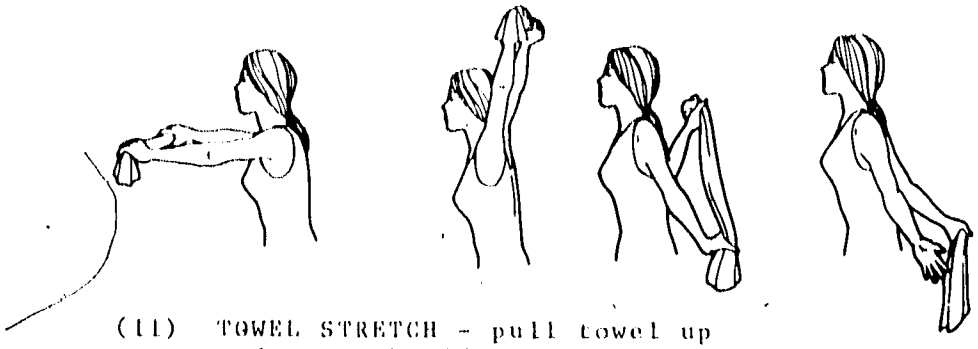
(8) DONUT STRETCH - hip and front of thigh



(9) GROIN STRETCH - lower back and groin muscles



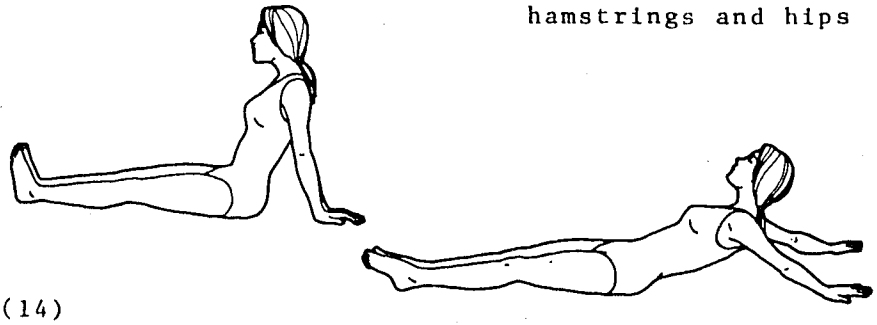
(10) TAIL LEG STRETCH - excellent for quadriceps



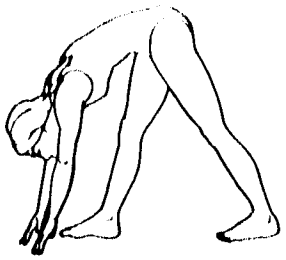
(11) TOWEL STRETCH - pull towel up and over shoulders, excellent for shoulders

(12) HUPLERS STRETCH - excellent for hamstrings and back

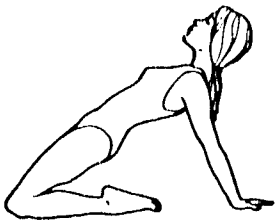
(13) SPLIT - lower back, hamstrings and hips



(14)
SLIDE - slide arms back slowly, good for shoulders, upper chest and back



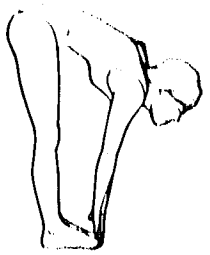
(15) TOE TOUCH - hamstrings, switch legs



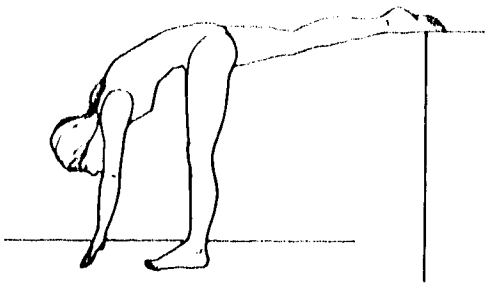
(16) REACH BACK - thighs, stomach, back and shoulders

(17) ELBOW PULL - shoulders

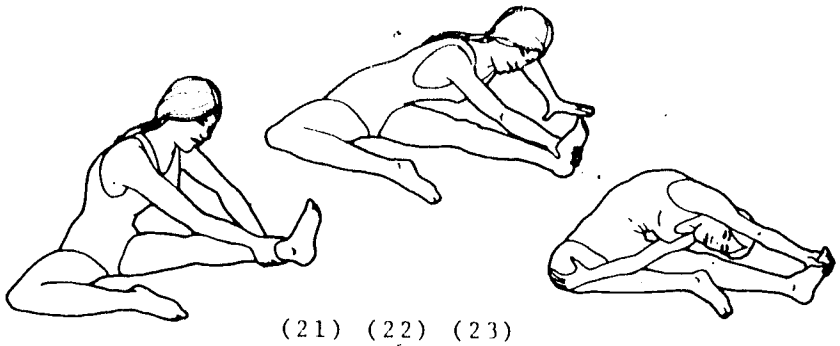
(18) ARM RAISE - shoulders, neck and trapezus



(19) TOE TOUCH - lower back and hamstrings



(20) SIDE LEG STRETCH - leg abductors, hips, back



(21) (22) (23)

SITTING HURDLES - hamstrings, quadriceps and back

EXERCISES NUMBER -

4, 7, 8, 10, 12, 15, 17, 20, 21, 22, and 23 should be repeated with both sides of the body.

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ACUTE - of short duration, rapid, brief
BURSA - A closed sac lined with a synovial like membrane and containing fluid. Bursae are found or formed in areas subject to friction.
CAPSULE - A membranous structure enveloping an organ, a joint or other part.
CHRONIC - Of long duration, repeating.
CONTUSION - A bruise.
CRYOTHERAPY - Treatment by use of cold.
DISLOCATION - Luxation; a disarrangement of the normal relation of the bones entering into the normal formation of a joint.
EDEMA - Abnormal accumulation of fluids in tissues or cavities.
ETIOLOGY - The cause of an injury.
FRACTURE - A broken bone; an interruption in the continuity of a bone.
-itis - An inflammatory disease of (suffix).
LIGAMENT - A band of fibrous tissue connecting two or more bones.
MENISCUS - Gristle-like padding on or between bones at the joints (cartilage).
PALPATION - Examination by touch.
SEPARATION (A-C separation) - A tear of the acromio-clavicular ligament which holds the clavicle to the scapula.
SPRAIN - A stretching or tearing of ligaments and connective tissue.
STRAIN - A stretching or tearing of a muscle, tendon or muscle fascia.
SUBLUXATION - Incomplete or partial dislocation.
SYNOVIAL FLUID - A clear fluid the function of which is to serve as a lubricant in a joint, tendon or bursa.
TENDON - A band of dense, tough tissue forming the termination of a muscle and attaching the muscle to a bone.

[illegible]

[illegible]

[illegible] important [illegible] evaluate the nature of an injury [illegible] the subject of treating [illegible] without medical supervision, the coach has the responsibility to determine the extent of the injury. It is not to say that the coach should play the role of physician, but he or she should be knowledgeable of how to injury evaluation and recognition. The coach should be able to render immediate care to the injury and refer the athlete to a physician when necessary.

Injuries can be classified in a number of ways. For this article, we will use two classes, exposed and unexposed. An exposed injury is external in nature and results in exposure of skin. Unexposed conditions do not break the skin and the injury is internal in nature. The majority of conditions noted in synchronized swimming are unexposed. Also, it is important to note that sports injuries result from either acute or chronic occurences. Acute injuries occur suddenly and are usually short in duration. Chronic injuries usually are incurred gradually over a long period of time, stemming primarily from a series of acute episodes. As a coach, you will see both acute and chronic conditions. It is necessary to be able to recognize typical symptoms of both classifications.

INJURY INSPECTION

To properly evaluate an injury a process should be used to evaluate the extent of an injury. We should be able to reveal the site of the injury and estimate its severity. Detection of the injury can be done in a number of ways. Injury evaluation can be simplified if the coach understands the mechanism or sequence of the injury. Evaluation is continued by methodically inspecting the injury.

Injury evaluation can be simplified if we follow an orderly sequence. This evaluation technique should be used for every injury, no matter how severe. The following three steps should be followed:

History: Take a good history pertaining to the injury

sequence. Ask the individual such questions as:

How did it happen?
When did it happen?
Have you injured this area before? If so, what happened then?
What kind of pain do you feel?
Was it evaluated by a physician?
Did you hear any noise when it happened?

After you have collected data about the injury, then ask the athlete to point to the area that "hurts the worst." If they are specific in their reaction, it will make the evaluation somewhat less complicated.

Inspection: Visual examination will give the evaluator pertinent information about the injury. By looking at the injury we can note any obvious deformity, swelling, and skin coloration. It is advisable to compare the injured body part with the opposite body part if this is possible. When we compare the "good" to the "bad," we actually have a good basis of comparison.

Palpation: Palpating or feeling the injured area with your fingers often can reveal several factors, namely the extent of point tenderness and whether the injury involves soft tissue or bony tissue. Palpation can often determine a deformity that may not be noted in the visual examination. While palpating the skin, be aware of body temperature. Note if the area is colder or warmer than the rest of the body. These can be important signs of circulatory impairment (colder) or inflammation (warmer). During palpation we can palpate bony prominences, ligaments, tendons and muscles. Following palpation, the examiner might ask the individual to gently move the body part to her point of pain. Movement should not be done if you suspect a fracture and/or dislocation. In less severe injuries, such as strains and sprains, range of motion testing is done. First have the athlete actively take the extremity through pain free range of motion. Then passively take the athlete through range of motion to the point of pain. Lastly, manually muscle test the injured part through range of motion. Manual muscle testing can

distinguish which muscle or muscles are strained. Range of motion testing allows you to note any increase or decrease in motion and to compare strength between the "good" and the "bad" extremity.

The above three steps may seem involved but even the most inexperienced trainer or coach can and should try to follow the three steps. Remember: H.I.P. - history, inspection, palpation. It will make your evaluation easier. Collect basic information and as you become more aware of conditions your evaluations will become better. It is most important to take a good history. As a good history gives the physician pertinent information, it will also enable you to possibly eliminate certain problems and most of all, if the injury is related to a certain technique the swimmer is using, maybe she needs correction on that technique. Many chronic conditions occur and persist because the swimmer is not performing the technique properly. If this is the case, the coach can try to eliminate or lessen the problem through coaching.

COMMON ATHLETIC INJURIES AFFECTING SYNCHRONIZED SWIMMERS*

Acute Conditions

Strain is a stretch, rip or tear in a muscle, muscle fascia or tendon.

Etiology: muscle imbalance
abnormal muscle contraction
abnormal range of motion (forceful)

Symptoms: muscular spasm
loss of muscle function
pain
swelling
indentation due to muscle tear

Sprain is an overstretching or a tear of ligaments and connective tissue around a joint.

*Information adapted from Klafs, C.E. and Arnheim, D.D.: Modern Principles of Athletic Training, St. Louis, 1977, The C.V. Mosby Co.

Etiology: forceful abnormal range of motion in a joint
twisting

Symptoms: swelling
pain
skin discoloration
joint instability

Contusion is a crushing of soft tissue (a bruise).

Etiology: compressive external force to soft tissue

Symptoms: skin discoloration
pain
swelling
possible limitation of movement due to pain

Dislocation is a total disunion of bone opposition between articulating surfaces.

Etiology: external force causing the joint to go beyond its normal range of motion

Symptoms: loss of limb function
deformity
swelling and point tenderness

Subluxation is a partial or incomplete dislocation.

Etiology: same as dislocation

Symptoms: sensation that something "slipped out" and back in
loss of limb function
swelling and point tenderness

Fracture is an interruption in the continuity of a bone; a broken bone.

Etiology: compression of bone
crushing force to bone
overstretching or shearing trauma

Symptoms: deformity, bony deviation
swelling
direct tenderness
crepitus ("crunching" or grating effect)
false joint
discoloration

Chronic Injuries

Tendinitis is inflammation of a tendon of a muscle.

Etiology:
- improper care of muscle strain
- sequelae of acute strains to a muscle/tendon
- improper performance technique
- overuse syndrome

Symptoms:
- pain on muscle function
- pain at tendon attachment
- crepitus (feels "crunchy" or raspy)
- swelling

Bursitis is inflammation of a bursa.

Etiology:
- trauma
- overuse in a abnormal fashion

Symptoms:
- swelling
- pain
- limitation of range of motion

Synovitis is inflammation of the synovial membrane, often known as "water-on-the-knee" when the knee synovia is inflamed.

Etiology:
- trauma
- overuse in an abnormal fashion

Symptoms:
- swelling
- pain
- limitation of range of motion

Chondromalacia is a degeneration of the back of the patella (knee cap).

Etiology:
- several minor or severe injuries to the knee or patella

Symptoms:
- chronic pain
- weakness in quadriceps muscle group
- catching or locking sensation
- point tenderness around patella
- swelling

SHOULDER

The muscles are the locations for most shoulder injuries in swimmers. This can be attributed to the great amounts of work and forces applied to the shoulder while sculling. The muscles stabilize the

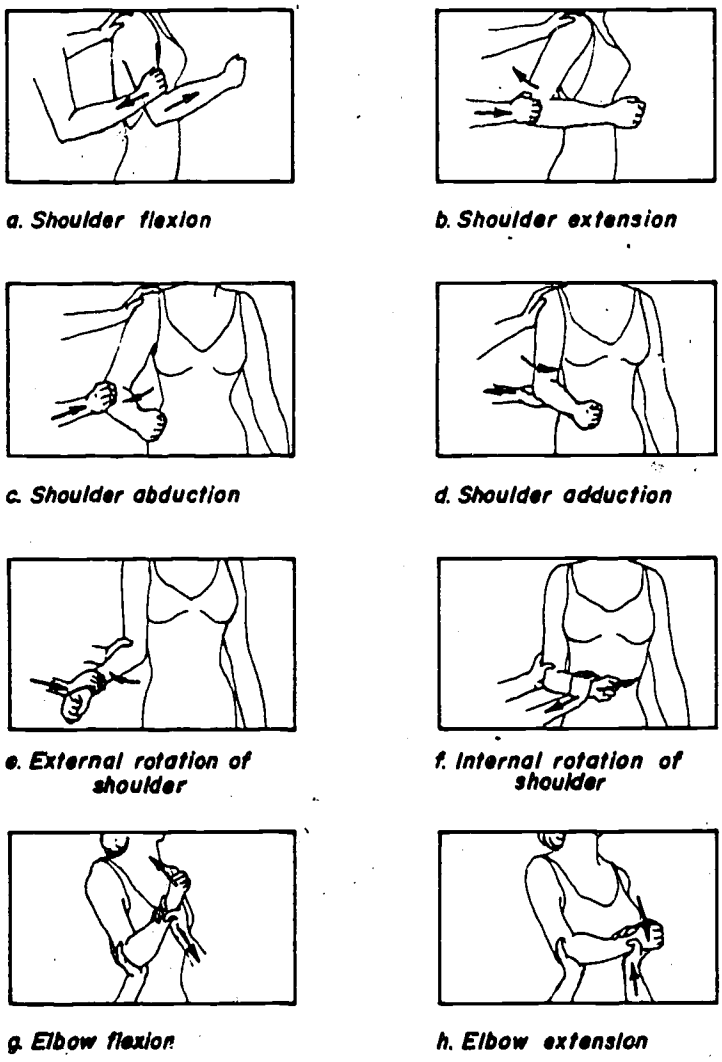
shoulder and compensate for the weakness seen in the bony and ligamentous arrangement. Common muscle injuries include muscle strains and tendinitis. Therefore, it is important to understand the basic muscle arrangement and muscle functions of the shoulder.*

Knowing the anatomy is important but you can easily check which muscle or muscle groups are injured without specifically knowing the exact muscle. Figure 5** shows the muscle testing done for the upper arm. Each movement can be checked by you applying gentle resistance through the full range of motion. If the swimmer has pain when you resist the movement then there is a possibility of a muscle injury. Always resist the athlete through all ranges of motion to decide which muscles are injured. It is important to check the opposite shoulder's range of motion so that you can compare the increase or decrease motion noted on you evaluation.

ELBOW, WRIST AND HAND

It is felt by the author that the bony structures of the elbow, forearm, wrist and hand are not frequently injured in synchronized swimming. The most common injury seen in this area would be muscle strain often induced by overuse. The prime movers and their functions have been listed in Figure 9**. If you should desire more information regarding this region, please refer to the references at the end of this section.

*Ed. note: see Daniels, Appendix A, pp. 184-195
** Ed. note: Figure numbers appear out of order but are placed correctly in this article.



a. Shoulder flexion

b. Shoulder extension

c. Shoulder abduction

d. Shoulder adduction

e. External rotation of shoulder

f. Internal rotation of shoulder

g. Elbow flexion

h. Elbow extension

Fig 5. Muscle Testing of the Upper Arm

KNEE

The knee is often injured in synchronized swimming due to the stresses applied to it during the eggbeater kick. This kick can traumatize the knee unless the knee is strong and the proper technique is used.

There are a number of injuries and conditions which occur at the knee joint. Evaluation for ligament, meniscus or cruciate injuries should be done by an orthopedic physician. When in doubt of your evaluation, consult a physician. Fewer or even less severe injuries may be noted if the muscles surrounding the knee joint are strong. It is important to condition the knee joints throughout the full range of motion. Often muscle injuries occur to a joint when a muscle group on one side of that joint is stronger than the muscle group on the opposite side. Therefore, equal conditioning should be done to both sides of the knee joint or any joint within the body. To compare strength between the hamstrings and quadriceps use the muscle testing techniques in Figure 8.* Manual muscle testing is a means to compare each knee's strength in the hamstrings or quadriceps muscle groups. These testing techniques should also be used when evaluating muscle injuries at the knee joint.

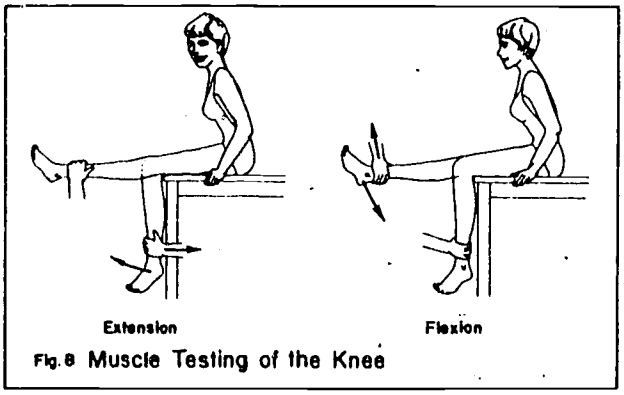


Fig. 8 Muscle Testing of the Knee

*Ed. note: Figure numbers appear out of order, but are placed correctly in this article.

NORMAL RANGE OF MOTION[1]

Shoulder

Flexion - 90°	Extension - 45°
Abduction - 180°	Adduction - 45°
Internal Rotation - 55°	External Rotation - 40°-45°

Elbow

Flexion - 135°	Extension - 0°/-5°
Supination - 90°	Pronation - 90°

Wrist

Flexion - 80°	Extension - 70°

Hip

Flexion - 120°	Extension - 30°
Abduction - 45°-50°	Adduction - 20°-30°
Internal Rotation - 35°	External Rotation - 45°

Knee

Flexion - 135°	Extension - 0°
Internal Rotation - 10°	External Rotation - 10°

[1]Adapted from Hoppenfeld, Stanley. Physical Examination of the Spine and Extremities. New York, Appleton - Century - Crofts, 1976.

IMMEDIATE INJURY CARE

Acute injuries will need immediate treatment following your evaluation. Treatment phases can be divided into two categories--early phase and late phase. Early phase of injury treatment involves four procedures: cold application, compression, elevation and immobilization. It is easy to remember the letters I.C.E. for ice, compression and elevation. These steps are designed to hinder swelling and decrease effusion of fluids to the injury site.

EARLY PHASE OF TREATMENT

Cold Application

Cold application will cause capillary vasoconstriction thus decreasing the amount of blood flow into an area. Along with vasoconstriction, cold will decrease muscle spasm, inflammation and pain sensations.

Compression

Compression is provided by the application of an elastic bandage. Choose the correct size for the area you are wrapping. I feel it is best to apply a spiral wrap with approximately 1/2 to 1/3 of the strength taken out of the wrap for compression to an acute injury. Be aware that the wrap may cause constriction of blood vessels if applied too tightly. Instruct the athlete that if she feels a tingling sensation, lack of sensation or any other abnormal sensation, that she should remove the wrap and reapply it with less pressure. Be sure the athlete knows how to apply the elastic bandage. It is best to remove it at bedtime and rewrap the injury in the morning.

Elevation

Elevation requires the injury be elevated above the level of the heart, if possible. This will prevent fluid accumulation at the injured area. Elevation enhances venous flow and will hopefully

minimize swelling in conjunction with ice and compression.

Immobilization

Immobilization varies dependent upon the specific injury. If a physician orders complete immobilization of the upper extremity he will use a sling or shoulder immobilizer. Lower extremity immobilization is done with the use of crutches and joint immobilizers. Partial immobilization or rest may mean the athlete does not perform an activity that aggravates an injury. Often times a few days rest can make a great difference when treating chronic conditions such as tendinitis or bursitis. Consult a physician when immobilization and rest are indicated.

SUGGESTED COLD THERAPIES

It is important to note the length of time cold applications are used and the frequency of treatments. Ice bags, cold whirlpools, cold hydrocollators, ice slushes and ice towels are applied 20-30 minutes. After approximately 30 minutes the body reacts to the cold and begins vasodialation to warm the body back to normal temperature. Therefore, instruct the athlete to remove the ice after 30 minutes. Patient tolerance should be noted during the treatment. If she complains of any side effects, such as extreme pain, nausea or discomfort, remove the ice and select a different cold therapy. Cold therapy can be used during the first 1-72 hours, depending on the severity of the injury.

Ice Bags

Plastic bags filled with ice are the most economical cold modality. Commercial cold packs can be purchased if you do not have access to ice cubes.

Apply the ice bag to the area using a wet towel or wet elastic wrap between the injury and the ice. Ice bags should be applied for 20-30 minutes, a minimum of three times daily for the first 1-72 hours.

Cold Whirlpool

Average temperatures for a cold whirlpool range from 40 -60 F. Length of treatment time is 20-30 minutes.

Cold Hydrocollators

Cold hydrocollators are commercial cold packs kept in a stainless steel unit at 10 F. They should be wrapped in a wet towel and applied to the injury for 20-30 minutes, three times daily for the first 1-72 hours.

Ice Slush

A bucket of water filled with ice chips. This method of cold therapy tends to be the most uncomfortable. Ideally, treatment time is 10-20 minutes. The athlete will immerse the extremity in the bucket, remove when painful, and return it to the slush as tolerated. This is used mostly for injuries to the hands and feet.

Ice Towels

Wet towels containing ice cubes or chips. Treatment time is 20-30 minutes, three times daily for the first 1-72 hours.

Ice Cups

Ice cups are paper cups filled with water and frozen. Peel the paper back, smooth the ice with your hand, and rub ice directly onto the skin. Treatment time is between 7-10 minutes. This cold modality can be used the second day of cold therapy if desired. Some therapists and trainers feel that due to the fact that the ice is rubbed directly to the skin, chilling is rapid, and the body in turn will rapidly start vasodialation. If so, ice cups are not indicated in the first 24 hours because we do not want to increase blood flow to the area.

LATE PHASE OF TREATMENT

The last phase of treatment is designed to enhance the healing process, enabling the athlete to return to normal activities. During the last phase, heat therapy, rehabilitative exercises and strengthening programs are used.

The heat therapies can be divided into two groups: superficial heat and deep heat modalities. Most coaches and athletes have access to the superficial heat modalities. Deep heat modalities require a physician's prescription and a physical therapist to apply them. Therefore, I will not go into detail concerning the use of deep heat modalities.

Superficial and deep heat modalites cause vasodialation of blood vessels thus causing increased circulation, relaxation and analgesia. Therefore, heat treatments will enhance healing. It is important to begin heat therapy when you feel the bleeding and swelling have stopped. If you begin the heat treatment too soon you will cause increase edema. Late phase of treatment usually starts after 48-72 hours, depending on the severity of the injury. Consult your physician when in doubt.

SUGGESTED HEAT THERAPIES

Warm Towels

Place towels in sink under hot water, wring out and apply to injury. (If they are too hot to pick up, they are too hot to use.) Change as they cool down. Length of treatment time is 20 minutes, three times daily.

Warm Shower

Suggest that your athlete stand in the shower for 20 minutes, three times daily. This is ideal for shoulder and back injuries. It is suggested that they do this prior to entering the water if they have an injury to either the shoulder or back.

Warm Whirlpool

Average temperature for a warm whirlpool when treating an extremity is between 95 and 105 F. Full body whirlpools should never exceed 100 F. Treatment time is 20 minutes at least twice a day. Gentle exercise can be done while in the whirlpool.

Warm tub soaks or the use of a bucket of warm water can be substituted. Always check the temperature. What seems warm to you may be hot to another. Depend on a thermometer and not your hand.

Hot Hydrocollator

Hot hydrocollators are commercial hot packs. They are canvas bags filled with a silicon material. They are kept at approximately 150 F in the hot pack unit. They should be wrapped in at least eight layers of towelling. Length of treatment time is 20 minutes, three times daily.

Heating Pads

Heating pads can be set at low, medium and high. Caution the athlete that the heat should be a "comfortable warm" sensation. Anything other than that is too warm. Treatment time can be 20-30 minutes, three times daily. Warn your swimmers not to go to bed with the heating pad on. It is electrical and can cause severe burns.

Deep Heat Modalities

Deep heat modalities include ultrasound, short wave diathermy and microwave diathermy. All three are good when applied properly and under a physician's supervision.

Heat therapy can cease when the athlete feels normal, pain is diminished and normal range of motion is attained. It may be necessary to continue rehabilitative exercises even though you have stopped heat treatments.

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COMMON ORTHOPEDIC PROBLEMS AFFECTING SYNCHRONIZED SWIMMERS

Marti Tucker, BS, RPT

Evaluation of our swimmers during the weight training sessions at Squaw Valley, revealed some interesting observations regarding faulty posture and muscular weaknesses. Information from both coaches and swimmers was also gathered at Senior National meets through posture clinics and informal sessions. Discussion took place on the most common joint strains, sprains and/or irritations familiar to synchronized swimming. Generally, participants are in good physical condition with very few injuries encountered in our sport that would require extensive physical therapy treatment and /or surgery. However, we felt that it would be valuable to both coaches and competitors to discuss the above mentioned affectations and offer suggestions, corrections, and exercise programs to avoid further complications or extensive injury.

Weight training and flexibility programs are equally important in developing strength and endurance and in prevention of injury. Since these topics are being covered in other sections of this manual, they will not be discussed in any length, only to emphasize that these two entities, in addition to good coaching, nutrition and a strong water training program, seem to be making the difference in development of the top caliber swimmer. Briefly, I will mention that in observing the swimmers working out on the various stations of the Universal Gym, the muscle groups that appeared weakest were the arm muscles, including the shoulder rotators and the deltoid muscles, the triceps and biceps of the upper arm, and wrist flexors/extensors. All of these are extremely important to the skill of sculling and more specifically, support sculling. The abdominal (stomach) muscles also showed weaknesses when the girls performed bent knee sit ups on the slant boards. These muscles are instrumental in maintaining good posture and also strong, straight vertical positions in figures. Finally, the quadricep and hamstring muscle groups which are responsible for full extension in ballet legs and strength in kicking (particularly eggbeater), and the tendon

and ligamentous structures surrounding the knee joint, proved to be weak.

POSTURE

What is posture? It is the proper balance and alignment of the spinal curves of the body in the upright position. If one were to drop a plumb line through a side (lateral) view of the body, it would cross the mid-ear lobe, mid-shoulder, midway between the chest and back, mid-hip bone area, and slightly forward of the knee joint and ankle bones. In observing alignment from a rear (posterior) or front (anterior) view, the plumb line would coincide with the midline of the body with fairly equal distribution on either side of the line. If both legs are equal, the hip bones (pelvis) will be even as will the shoulders.

Evaluation of the synchronized swimmers at the training camp and at national meets, indicated many typical posture faults including slight forward head, rounded shoulder, "sway back" (lordosis), protruding stomach and "back knees" (hyperextension). One of the key factors for control of good posture is adequate abdominal strength and proper "pelvic tilt" (flattening of the curve in the low back). The angle of the pelvis (hip bones) determines the angles of alignment of the upper curves of the spine and if properly controlled, will improve and maintain a more erect posture. In more detail, common posture problems view from the side, include:

Forward Head - The head and neck are held forward and downward with the chin pulled toward the neck and the face downward.

Round Upper Back - Also known as thoracic kyphosis. The normal curve of the thoracic spine is increased and may be accompanied by a sway back and rounded shoulders.

Round Shoulders - The shoulders are forward with the tip of the acromion forward of the gravitational line. The shoulder blades are

separated and their borders appear pointed or prominent.

Hollow Back (Sway Back)- Also known as lumbar lordosis. The normal curve in the lumbar spine is exaggerated. The pelvis tips down in front and the abdominal muscles become stretched. We then see the stomach protrude and the back muscles and posterior ligaments in the lumbar region are shortened and become tight, holding up the back of the sacrum (tail bone) and rotating the pelvis forward.

Hyperextended (Back) Knees - In observing the legs from a lateral view, the backs of the knees are excessively curved (bowed) backward with no indication of even the slightest bend or flex at the posterior surface of the joint.

Posture faults viewed from the back (posterior) are generally termed as Scoliosis, a word derived from the Greeks, meaning twisting or bending. Very few spines are straight laterally, and what is seen, are defined curves to one side or the other of the spine. The most common scoliosis is the "C" curve, which consists of a long convexity to one side. The "S" scoliosis consists of reverse curvatures, laterally in one direction in the upper back and the opposite direction in the lower back. There can be unevenness of the shoulders with one lower than the other and some rotation in the spine. This causes prominence of the ribs in the posterior aspect on the side of the curve, with the corresponding shoulder blade pulling away from the ribs. If there is a difference in leg length, or hip joint problems, the hips (iliac crests) will be uneven.

A method of practicing good body alignment is performance of the Standing Pelvic Tilt. Stand with your back to a wall and with both heels about 10 inches from the baseboard. You may begin with knees slightly bent and the shoulders forward, if necessary. Flatten the low back against the wall by pulling up the front of your pelvis, hold it as you straighten your knees and raise your shoulders. Walk one foot

at a time back toward the wall, maintaining the pelvic tilt until your heels are about 5 inches away. Hold this posture and walk away from the wall. THIS POSTURE SHOULD BECOME A HABIT.

Contributing factors to "sway back" posture of the lower spine with synchronized swimmers could be the over emphasis on arched backs in split and walkout positions in figures. Coaches often stress increased flexibility of the spine without the accompanying abdominal strengthening exercises to counteract this extreme body position. The "sway back" posture is often comparable to the typical "gymnast's walk." "Back knee" or hyperextended knees in swimmers may stem from the stressing of full extension in ballet leg positions which tends to over-stretch the hamstring musculature in the back of the knee. Forward head and rounded shoulders can be a problem of the "too tall" adolescent affected by peer pressure, and inner emotions also plays a role in this lazy posture. We see the shorter girls stretching to their full height by standing on their toes, protruding the chest and arching the low back. The full bosomed girls, affected by peer pressure or modesty, often assume a round-shouldered posture for concealment. Muscular tension, particularly in the neck, shoulder and shoulder blades is occasionally experienced by swimmers before competition and can have an adverse effect on posture. The practice of relaxation techniques can aid in decreasing much of this tension.

Perhaps, in some ways, our swimmers are too flexible and we need to counteract this with a more intensive muscle strengthening program to prevent joint laxity, muscle weakness and poor body alignment. The coach can play an important role in spotting obvious posture faults and if in need of professional advice, can contact a physical therapist who could conduct a postural screening evaluation and suggest appropriate exercises to correct the problems. "Good posture is a good habit. Once well established, it should take little voluntary effort to maintain it. Attainment of good posture should not be regarded as a rigid disciplinary

measure, but rather as the development of a habit which contributes to the well-being of the individual."[3]

Two basic exercises for increasing abdominal strength are: 1. Pelvic Tilt - on floor with knees bent and feet flat. Tighten the abdominal muscles and squeeze the buttocks together. Flatten the low back against the floor by rocking the hips back (pelvis). Hold five counts and release. Do not push down with your feet or hold your breath. 2. Sit Up (Curl Up) - same position as above, doing pelvic tilt first. Tuck chin and slowly raise your head and shoulders (curl up) and reach for your knees with both hands. Hold five counts while breathing out slowly. The feet may be hooked under and object for stabilization. You may also vary the position of the arms by crossing them on the chest or putting the hands behind the head. If one has access to a weight training room, abdominal strength can be enhanced by performance of the sit up on a slant board, hooking the feet under the cushioned pads for stabilization. When this is mastered, use of a 5 lb. hand weight held behind the neck can be employed for added resistance.

KNEE PAIN

The most common irritation of the knee joint experienced by our swimmers seems to be chondromalacia of the patella (knee cap). This is a degenerative process, cause unknown, which involves the under surface of the knee cap and the highest incidence is found in young adults. Pain may be variable, exhibited as a catching, instability; a locking, popping or crackling; a weakness or swelling in the knee joint, or tenderness to pressure. Ruling out sudden trauma, arthritis or an injury related problem, possible causes that I see in the physical therapy clinic are as follows: postural faults in standing and walking, as with hyperextended knees; wearing earth shoes with a negative heel or heavy hiking boots; weak muscles and ligaments surrounding the knee joint which allows the knee cap to move freely; participation in a sport or strenuous activity for

which the unconditioned person is unprepared. All of the above reasons may cause undue stress on the knee cap, forcing it back into the joint, allowing increased mobility without support and consequently irritating the under surface of the patella (knee cap). This induces wear and tear on the cartilage material within the joint. It has already been stated that synchronized swimmers are occasionally confronted with this irritation, resulting from forceful knee extension in various figures without the benefit of adequate strength in the quadricep and hamstring muscles. This is the reason why weight training and progressive resistance exercise programs are so important for strength development and avoidance of injury.

In order to correct a chondromalacia irritation with the presence of "back knee," I recommend walking and standing with a slight bend in the knees, avoiding the "snapping back" action. Also important, is the avoidance of negative heel (earth shoes and heavy hiking boots which tend to increase pressure on the knee cap as the heel strikes the ground in walking, by forcing it further into the joint and producing irritation. Any knee bending type exercises or activities, such as stair climbing, are traumatic to the joint and should be avoided until the pain has subsided. The basic strength building program that is used with a high incidence of success is straight leg raises with graded weights, performed in three positions: sitting, sidelying, and on the stomach. Exercises are to be done 10 times each (slowly), 2-3 times a day. Application of ice to the knee is done before and/or after exercise if swelling or irritation are present. Since bending (flexing) the knee joint tends to cause irritation, avoid this action in the exercise regime.

Knee strain or sprains are also encountered in our sport. As explained in the basic anatomy terminology, sprains may vary from a complete tear of a ligament to a minor tear of a few fibers without the loss of ligament stability. Strain may be considered a physical force on the tissues exceeding normal stress, but not causing deformity or damage. The knee joint

sustains a sprain when a force is exerted that exceeds normal range of motion of the joint. Abnormal motion includes abduction (outward) or adduction (inward) of the extended knees, excessive rotation, hyperextension or hyperflexion or any combination of the above.[1]

A contributing factor to knee strain in synchronized swimming is the eggbeater or alternating whip kick which is used in routines or in a varied form in the breast stroke. Injury is usually to the tibial collateral ligament, part of the medial collateral ligament located on the inner surface of the knee. The action of holding the hip and the knee in the flexed position, knee pointed forward to outward with the constant inward rotating whip of the lower leg, produces a constant build-up of tension on the joint and can be the cause of eventual strain. The area on the inner surface of the knee is usually sore, with point tenderness evident when palpated.

Treatment for this type of strain and other ligament strains usually consists of ice, pressure-wraps and elevation when out of the water. Ultrasound, when ordered by the physician, has also proven valuable in relieving the symptoms. Cortisone injection only plays a minor role and is used as a last resort. The kick itself can be modified so that there is less strain on the inner surface of the knee and occasionally, total rest may be necessary for a persistant problem.[4]

In addition to the previously mentioned straight leg raises, isometrics and short arc exercises are also used in a strength building program. Quad Sets (tightening the quadricep muscles): With leg straight try to flatten knee and tighten the muscle in front of the thigh. Hold 5 counts; relax. Hamstring Sets: With the leg straight, push heel down into floor and tighten muscle in back of the thigh. Hold 5 counts; relax.

Short Arc Quad - Large towel rolled under knee; keeping back of knee on roll, try and lift heel until leg is as straight as possible. Hold 5 counts; relax.

Short Arc Hamstring - On stomach with pillow under hips slowly bend knee, bring in heel toward buttock, approximately one-half way. Hold 5 counts; relax.

All exercises are to be done slowly, 10 repetitions each, 2-3 times per day.

SHOULDER PAIN

The action of sculling, specifically support sculling, can be a major source of shoulder pain and discomfort in our swimmers. The motions of external and internal rotation at the shoulder joint in the pushing away-pulling action of the support scull, can cause undue stress on a joint and its surrounding musculature which has not been properly stretched and strengthened to withstand these forces. In analyzing the support scull action, the shoulder joint performs the "unnatural" type movement that can place an unbelievable amount of strain on the tendons of the joint. "Pain can result in any of three conditions: 1. abnormal strain on a normal joint, 2. normal strain on an abnormal joint, or 3. normal stress upon a normal joint when the joint is unprepared and graded for that particular activity."[2] The third condition aptly applies to synchronized swimmers who have not adequately prepared themselves through strength and flexibility training.

Tendinitis is defined as an inflammation of the tendon sheath, the tapering end of a muscle belly which attaches itself to a bony prominence. This affectation is responsible for 90% of shoulder pain and disabilities.[2] It is often classified in other terms as bursitis, capsulitis or frozen shoulder. Inflammation of the biceps tendon seems to be the one most prone to strain in the support sculling action, and to a lesser degree, the external rotator and deltoid muscles are affected. The first symptom is pain which can vary in intensity. This is usually followed by some limitation in shoulder motion. Rest and treatment at this stage may reduce pain and allow the return of pain-free motion, although it may not be necessary to completely eliminate activity. Ice is the preferred treatment to decrease irritation during the acute phase, usually 2-3 days. This can

be followed later by moist heat. Sometimes a sling is used to immobilize the joint, but this should not be prolonged as the shoulder joint will "tighten up" causing further problems. Active range of motion exercises can be instituted within 4 days and the most successful seem to be Codman's pendulum exercises. These are basically arm swinging exercises performed in a gravity-assist position (bending forward at waist) with 3-5 lbs. of weight in the hand. 1. Swing arm forward and back. 2. Swing arm from side to side across body. 3. Swing arm in a circle; reverse direction of circle. These are done at 10 repetitions each, 2-3 times daily. In more severe cases, analgesics such as muscle relaxants and steriod injections are employed by the physician.

The best method of avoiding shoulder strain and discomfort is an intensive shoulder and arm strengthening program coupled with flexibility exercises. Increasing the strength and endurance of the bicep and tricep muscles and deltoid and rotator muscles of the shoulder joint can aid in preventing injury and improving the sculling power of our swimmers.

SWIMMER'S SHOULDER

Since our synchronized swimmers participate in heavy swimming workouts in the early season and continue them to some degree throughout the year, they are also susceptible to a condition called "Swimmer's Shoulder." The medical definition of the affection is impingement of the humeral head and the rotator cuff musculature on the acromion process during abduction of the shoulder.[6]

In the freestyle stroke, abduction of the shoulder occurs during the recovery phase when the arm is up or out of the water. At this time the shoulder joint is also in external rotation and elbow flexion. During the pulling phase of the stroke the arm comes down into the water in adduction, internal rotation and elbow flexion. In addition to these two phases, 90-100 degrees of body roll occurs, with the swimmer rolling into the stroke to get more reach and power on the pull. Competitive speed

swimmers average 15 strokes per 25 yards with 10,000 yards per day. This can mean 21,600 strokes per week with 10,800 strokes per arm. Sixty percent of these laps are mainly freestyle or butterfly workouts, performed during early and mid-season, consequently, there are tremendous forces on the shoulder joint and its surrounding musculature.[6]

The shoulder pain that can result is usually anterior and is most common in freestyle and the butterfly competitors. It is rare in breast strokers and swimmers less than 10 years old. Backstrokers may have posterior as well as anterior pain which can be caused from subluxation of the shoulder joint. At the Olympic training camps, the occurrence was 50% in men and 60% in women, and with the national team, 54% in men and 68% in women. The women do take more strokes per length than men and in most cases, do not have the muscular strength and development of the male swimmers.

Swimmer's shoulder mainly occurs during heavy workouts or exercise and in some cases can be related to weight training. This is why it is so important to learn the proper technique when using any kind of weights. The treatment regime usually consists of warm-up (flexibility) exercises before activity and ice after activity. Ultrasound is often successful, but when the condition becomes too painful, decreased yardage, rest, anti-inflammatory medications, and injections are employed with surgery as a last resort.

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BODY COMPOSITION AND WEIGHT CONTROL

Edmund R. Burke, PhD

In the past several years interest has grown among synchronized swimmers and their coaches concerning body composition and weight control. "What are the normal values for percent body fat for well trained females," and "What is my ideal weight." In this section we will consider (1) what is body composition and how can we assess it in synchronized swimmers, (2) the latest finding on elite swimmers, and (3) methods of losing or gaining weight.

For purposes of simplicity, the body may be regarded as being composed of basically two fractions: (1) body fat and (2) fat free weight (lean body weight).

The total body fat exists in two basic storage sites. The first is defined as essential fat, and is found in bone, liver, spleen, spinal cord and brain. Essential fat can be used for energy and for the storage of fat soluable vitamins (A,D,E,K). Storage fat, the other major component, consists of the fatty tissues that protect the various internal organs, as well as the subcutaneous fat beneath the skin.

The percentage value for the average male is 15-17% and female 23-25%. The values for storage fat between males and females are about the same, 12 and 15% respectively. However, essential fat represents only about 3% of the average male, whereas essential fat is approximately 12% of the reference female. The larger quantity of essential fat in females is present predominantly in the mammary glands, bones, and other tissues. Most likely, it is related to child-bearing and hormonal functions.[3]

Among athletes, regardless of the sport preference, the body fat is generally lower, with the percentages again differing on the basis of sex. Extensive studies of many different athletes have shown the following percent body fat to be representative of various female athletes: runners 13-14%, gymnasts 14-15%, basketball 20%, swimmer 23%, and tennis 24%. Female distance runners are exceptionally

lean and some of the cases have been recorded under 10 .

The question of percent body fat and menstrual irregularities, including secondary amenorrhea (the abnormal cessation of menstruation) should be mentioned. At the present time, hard data supporting the notion that low percent body fat in females is detrimental has not been documented and further research is needed. As it now stands exercise and low percent body fat do not significantly affect the athlete. Clearly, in some athletes, the exact interaction of menstrual disorders, activity, and percent body fat remains to be answered.[1]

When the weight of body fat is subtracted from the total body weight, the remaining weight is referred to as lean body weight (LBW) or lean body mass (LBM). Lean body mass includes muscle, bone, skin, nervous tissue, etc. The larger the percent fat free weight an athlete has the larger their muscle mass and thus the greater force potential. In synchronized swimming considerable debate is now surfacing as to what is the ideal percent fat and lean body mass for the swimmer. The more lean body mass (muscle), the stronger the movements and figures; the more body fat the easier it is for the athlete to float. This question will be further debated later in the chapter.

The fat and lean components of the human body can be determined by several procedures. One procedure measures body composition by hydrostatic weighing and the other by simply circumferences or skinfold measurements.

It is common knowledge that fat people float better than thin people, and this is because fat tissue is less dense than other tissues. Consequently, hydrostatic weighing, which provides measures of body density and specific gravity, can also provide reasonably accurate estimates of the proportions of percent body fat and lean body mass.

In this procedure the athlete is completely

[illegible]

This value is corrected for residual lung volume (air left in lungs, after maximal expiration), which is determined by a spirometer. Further calculations will give density and percent body fat. The percentage of total body weight in pounds of body fat.

However, because of the elaborate equipment, complex procedures, and substantial time required for each individual tested, this method does not permit widespread use. Fortunately, simple methods using skinfold calipers have turned out to be quite suitable for determining lean body weight and fat weight.

The calipers work on the principle of measuring the distance between two points. The skin and subcutaneous fat is pinched between the thumb and fore finger. The pincer arms of the caliper exert constant tension at their point of contact with the skin. The skinfolds in conjunction with mathematical equations are used to predict body density and percent body fat.

Below is a prediction formula for body fat using skinfold calipers which was developed at Ohio State University to be specifically used with synchronized swimmers.

In order to make accurate measurements, it is important to use calipers which have the pressure built into the instrument itself. Practice and standardized procedures should be used when taking any skinfold measurement. The following procedures should be followed on females:

1. A full fold of fat should be pinched up from underlying tissue by the thumb and forefinger of one hand.

2. While the fold is held firmly between the fingers, the calipers should be applied to the fold beneath the fingers.

3. Take recordings to the nearest half millimeter.

4. Duplicate the measurements until two consecutive measurements agree within one millimeter.

5. In young women, the best prediction comes from a vertical skinfold over the iliac crest in the midaxillary line and from a vertical skinfold on the back of the arm halfway between the shoulder and elbow measured with the elbow extended.[4]

6. Computation of density:

$$\text{Density} = 1.07943 - 0.00220\ (\text{tricep skinfold}) + 0.0045\ (\text{suprailiac skinfold})$$

Computation of percent body fat:

$$\%\ \text{body fat} = 100 \times \frac{4.570}{\text{density}} - 4.142$$

BODY COMPOSITION CHARACTERS

Site and Group	Number	Age	Ht (cm)	Wt (kg)	Density	% Fat	LBW (kg)
Squaw Valley 1977 National Champions	8	20.1 (1.55)	166 (8.32)	52.7 (6.41)	1.051 (.007)	20.1 (2.95)	42.0 (4.2)
Squaw Valley 1978 Intermediate Camp	64	15.5 (1.97)	164 (7.56)	54.2 (6.97)	1.047	22.4 (4.27)	42.1
Squaw Valley 1978 Elite Camp	36	16.3 (1.92)	164 (5.08)	54.5 (5.11)	1.047	22.1 (3.98)	41.5
Ohio State 1979 AAU National Top 10 Teams	92	17.7 (2.16)		52.8	1.050 (.008)	20.5 (2.0)	43.5 (1.9)

BODY FAT OF SYNCHRONIZED SWIMMERS

With the testing performed at the Olympic Training Center, Squaw Valley, Ca., and at the AAU Nationals at Ohio State University a profile of total body fat and lean body weight in national class synchronized swimmers is now available to the elite as well as novice swimmer and coach.

Table I reports the results of the underwater weighing completed at the various sites. Mean and standard deviation are recorded. Height is recorded in centimeters (1 inch = 2.54 centimeters) and total weight and lean weight are in kilograms (2.2 pounds = 1 kilogram).

These results point out that the top synchronized swimmers are from 20 to 22% body fat. But, is 20 to 22% body fat the most ideal percent body fat for a synchronized swimmer? This question is now being raised by many coaches. Should the girls remain at this percentage and assume the fat adds in buoyancy or would a decrease in percent fat and increase in lean body mass (muscle) increase strength and execution of figures. These questions need to be answered by further research. Of course, it should be remembered that a routine requires a fair degree of aerobic fitness and a high percent body fat may have a negative influence on performance. At the present time it is safe to assume that the percent body fat of the girls should not be much above 22%.

Losing Weight

If you suspect that a particular athlete is overweight, only three alternative methods are available for reduction of weight: 1. increased energy expenditure and constant food intake, 2. decreased food intake and constant energy expenditure, 3. a combination of methods 1 and 2.

In most cases, energy balance is altered to create a negative caloric balance of approximately 1,000 kilocalories/day. Each week the athlete would lose approximately 2 pounds of fat (3,500 kilocalories

= 1 lb. fat). The caloric intake can be reduced by 500 to 800 kilocalories a day, and the hard training athlete, should never consume less than 2,000 kilocalories a day. Lesser intakes of energy will result in increasing utilization of muscle mass as an energy source. Less than 2,000 kilocalories a day and the swimmer will begin to feel sluggish, be more liable to over-stress symptoms, and be susceptable to illness. "Fasting" diets should have no place in their program.

In addition the swimmer should increase their energy expenditure by 250 to 500 kilocalories a day. Increasing the calories deficit through exercise is essential if weight is to be lost at a desired rate and as fat, while taking a 2,000 kilocalorie diet.[5]

The dieting athlete should observe the following suggestions:

1. Eat a well balanced diet.
2. Eat smaller, but more frequent meals.
3. Chew food slowly and thoroughly.
4. Avoid fasting and fad diets.
5. Replace water loss.
6. Reduce carbohydrate intake.
7. Decrease intake of solid fats.
8. Keep protein intake up.
9. Use unsaturated fats and oils.
10. Emphasize intake of fresh fruits and vegetables.
11. Snacks should be nutritious; no junk food.
12. Supplement diet with a multiple vitamin and mineral tablet.

Gaining Weight

For the synchronized swimmer who desires to gain weight, the increased mass should preferably represent muscles rather than fat. Simply adding body weight will not be to the swimmers advantage, unless the tissue can be utilized for increased performance. Thus the athlete should be encouraged to initiate a weight training program (if one is not already used) in conjunction with increased caloric intake.

A realistic schedule is important in any weight gaining program. An excess of 2500 calories is needed to gain one pound of lean body mass by the active swimmer. If she is already consuming 3000 calories a day, she can gain approximately two to three pounds each week if she is able to ingest 4000 calories a day. It is important that they do not exceed more than an extra 1000 to 1500 calories a day, if accumulation of excess fat is to be avoided. The high caloric diet should take place only on days of vigorous training.

Below are listed some guidelines to follow in a weight gaining program:

1. Check the general composition of the food they eat. Protein should average 15 to 20% of the diet. These levels will provide abundant protein to provide the amino acid building blocks for new lean body mass.
2. Check their living habits; are they getting enough rest and sleep.
3. Evaluate the diet in order to determine the caloric intake. The reason for underweight may be that the current caloric intake does not meet their daily needs.
4. Protein supplements are not needed if the athlete is consuming a balanced diet.
5. There are several high caloric food supplements on the market. For example, Ensure Plus (Ross Laboratories, Columbus, Ohio) contains 355 calories in an 8 oz. can, which is composed of 14% protein, 31.5% fat, and 54.5% carbohydrate. A can with each meal, along with the normal dietary intake, would be an effective means to increase both caloric and protein intake.
6. In recent years the use of synthetic anabolic agents (steroids) has received much publicity. The scientific literature is still not in agreement as to its positive effects of increasing muscle mass which will be of benefit to the athlete. What is known is that any female who takes them for as long as a few weeks may develop acne, deepening of the voice, excessive body hair, and enlargement

of the breasts (because some of the hormones are converted to the female hormone, estrogen).

It is obvious that the use of these hormones has no place in any athletics and will be detrimental to the swimmer in the long run.

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NUTRITION GLOSSARY

CARBOHYDRATE - An energy yielding nutrient of plant and animal origin composed of carbon, hydrogen and oxygen; simple sugars and starches are the forms of carbohydrate found in foods.

FAT - A nutrient of plant and animal origin that is composed of carbon, hydrogen and oxygen; fat is the most concentrated source of energy of the three energy yielding nutrients.

GLYCOGEN - The storage form of carbohydrate found in liver and muscle; used as a source of energy for muscular work.

GLYCOGEN LOADING - A two phase training technique involving diet and physical exercise that initially depletes the muscles of glycogen and then repletes glycogen stores to a greater level than had originally been maintained; for use by athletes participating in long endurance sports.

KILOCALORIE - The unit of measure for the energy that is supplied when food is oxidized in the body; kilocalorie is the amount of heat necessary to raise 4.2 cups of water one degree centigrade.

MINERALS - Elements which are found in the earth's crust and are essential for normal growth and maintenance of life; minerals are subdivided into macro- and micro- categories depending on the quantity required by the body.

PROTEIN - The energy yielding nutrient of plant and animal origin that is primarily composed of carbon, hydrogen, oxygen and nitrogen; approximately 20 amino acids may be combined in different patterns to form many different food proteins.

VITAMINS - Organic compounds needed in very small amounts to promote growth and maintain life; vitamins are classified as water soluble or fat soluble.

NUTRITION

A Part of the Winning Combination

Lorri Porcello, PhD

The influence of diet upon athletic performance was first studied and recorded by the Greek civilization in approximately the fifth century B.C. Prior to this time, the typical diet of athletes was primarily vegetarian and consisted of barley or wheat porridge, fruits, vegetables and goat's milk. In 450 B.C., a trainer named Dromeris of Stymphalus was the first to introduce the meat diet. He reasoned that muscle was extensively used in athletic activity and, therefore, athletes needed to replenish this muscle by eating large quantities of meat. This philosophy became widespread and persisted without question until 1866 when it was proven that physical exercise does not influence an athlete's protein requirement. Today many athletes still consume diets that are high in meat, even though scientific evidence has shown that this particular practice will not improve athletic performance.

Just as the philosophy of the high meat diet is based upon tradition, many other current dietary practices are founded on misinformation. Some coaches exclude milk from pregame meals because of unfounded beliefs that it hampers endurance performance and increases respiratory mucus secretions. Fried foods and pork are often restricted because they are believed to be difficult to digest. In addition, bulky vegetables and cereals are often avoided because they are also thought to be poorly tolerated. Certainly a few spices can be irritating for specific individuals; however, bulky vegetables and cereals are necessary for normal fecal elimination.

Dietary selection of athletes has been governed too long on the basis of tradition or superstition. Factors that need to be used in the planning of proper nutrition for the athlete include the nutritional requirements of the individual. These requirements are based on age and sex, additional needs imposed by the type and amount of activity performed and the effect of dietary supplementation on athletic performance. Parents and coaches should assume the

responsibility of providing sound nutrition advice to athletes so that dietary practices may help rather than hinder the athlete's attempts to improve performance.

BASIC NUTRITION PRINCIPLES FOR ATHLETES

Within the last 10 years the American public has become aware of the contribution that sound dietary practice makes to physical and emotional well-being. The proper diet is certainly necessary for the health of all people. This fact is especially true for infants, children and adolescents who are still growing and require nutrients to support the vital growth process. When an individual participates in rigorous physical activity, nutritional demands increase even further. So, the nutrient needs of children and adolescents involved in athletic competition are compounded by the on-going growth process and the increase level of physical activity. These children and teenagers have, perhaps, the greatest nutritional needs of any specific age group in the population. To help meet those requirements, the athlete must start with knowledge of the basic principles of nutrition and apply this knowledge in selecting a good diet.

Protein

Protein is the nutrient that is probably most misunderstood by athletes. Proteins are large, complex molecules of plant and animal origin which are primarily made of carbon, oxygen, hydrogen and nitrogen. Each protein is a combination of subunits called amino acids which are linked together to form one large molecule. There are approximately 20 major amino acids that may be combined in different patterns to form the many different food proteins.

When protein is digested, it is broken down into individual amino acids and absorbed for the body's use in this form. Thus, it is easily understood that the body really requires amino acids for maintenance of life rather than the large, complex protein-molecules, even though food proteins are the sources of amino acids in the diet. Of the 20 major acids, nine

are known to be essential and the remainder are called non-essential. An amino acid is considered to be essential when the body is incapable of synthesizing that amino acid and it must be provided in the diet. Non-essential amino acids may be made by the body from carbon, oxygen, hydrogen and nitrogen atoms and, therefore, do not need to be supplied in the diet. An important point to remember is that all amino acids are needed by the body but some (essential) must be provided in the diet and others (non-essential) can be made by the body.

Protein performs three primary functions. All of the cells that make up bodily tissues and organs have protein as an integral part of the cellular structure. Other compounds in the body are also proteins such as enzymes and hormones which help to regulate the bodily processes that are crucial to life. Finally, proteins may provide energy when sufficient amounts of other energy-yielding nutrients are not present in the diet.

It is surprising to most athletes to find that they do not need more protein than an inactive individual of comparable size and age. Muscular work does not significantly influence protein metabolism, so participating in athletic competition does not increase a person's need for protein. Athletes do, however, require more food energy or kilocalories to support the increased physical activity. If insufficient food energy is provided in the diet, protein will be used as an energy source rather than for growth and repair of tissue. Consequently, athletes do not need to eat great quantities of protein, but do need to eat enough food energy to allow protein to be used for growth and repair of tissues.

Carbohydrate

Carbohydrates are molecules of plant origin that contain carbon, oxygen and hydrogen and are smaller than protein molecules. The diet supplies two types of carbohydrate including the simple sugars and the complex carbohydrates. Sucrose or common table sugar, glucose and fructose are examples of the simple sugars.

Complex carbohydrates include the starches found in breads, cereals, potatoes, pasta and rice.

All carbohydrates are digested and absorbed in the form of monosaccharides, which are the subunits of the complex molecules. The function of this nutrient is to supply energy for the body and this is accomplished by sending glucose, a monosaccharide, into the bloodstream. The tissues may then receive and use glucose as a source of energy. Dietary glucose is absorbed into the bloodstream from the digestive tract and remains intact as an energy source for the tissues. Other monosaccharides, such as fructose, must be converted to glucose in the liver after they have been absorbed. The glucose is then released from the liver into the bloodstream to be used by the tissues.

It is recommended that all people, including athletes, consume 50 percent of their food energy or kilocalories in the form of carbohydrates. This nutrient is not stored in large quantities in the body; however, the liver and muscles contain a small amount of stored carbohydrate. Glycogen is the animal storage form of the nutrient just as starch is the plant storage form. Starch and glycogen are large molecule containing many monosaccharides. If too much carbohydrate and total food energy is consumed, the carbohydrate is converted to fat and deposited under the skin and around body organs.

Fat

The last of the three energy yielding nutrients to be discussed is fat. A fat molecule contains carbon, oxygen and hydrogen and is primarily composed of three fatty acids. Fatty acids are the subunits of fat just as amino acids and monosaccharides are the subunits for protein and carbohydrate. Fats of vegetable origin are mainly unsaturated, while animal fats are generally saturated. Fatty acids that will not accept additional hydrogen atoms are called saturated because the molecule is completely saturated with hydrogen. Similarly, unsaturated fats are so named because they will accept additional hydrogen atoms.

There are three reasons why fat is needed in the diet. Fat-soluable vitamins which must be supplied by the diet are found in fats of vegetable and animal origin, so that fats act as carriers of these nutrients. Second, one fatty acid is considered to be essential and that is linoleic acid. Remember that the term essential signifies that the compound cannot be made in the body and, therefore, must be provided in food. Most fatty acids can be synthesized from carbon, oxygen and hydrogen within the body. The consumption of one to two teaspoons of corn or other vegetable oil per day will provide an adequate amount of linoleic acid in the diet. Third, fat is a very concentrated source of energy. It provides two and a half times the amount of food energy or kilocalories as do protein and carbohydrate on an equal weight basis. Ten grams of protein and carbohydrate provide 40 kilocalories each, while 10 grams of fat provides 90 kilocalories.

In the United States, 40 to 45 percent of the kilocalories in the average diet are supplied by fat. Many health professionals have expressed concern that this level of fat intake will contribute to the onset and incidence of heart disease and recommend that only 30 percent of food energy be provided by fat. Table 1 provides information concerning dietary sources of fat, as well as protein and carbohydrate.

TABLE 1 - ENERGY PROVIDING NUTRIENTS

Nutrient	Common Food Sources
Protein	Meat fish, poultry, eggs, cheese, peanut butter, nuts, dried peas and beans, milk.
Carbohydrate	Breads, cereals, pasta, rice, potatoes, sugars.
Fats	Butter, shortening, margerine, vegetable oils, cream, salad dressing.

Vitamins

Vitamins are organic compounds that are needed in small amounts to regulate chemical reactions that are necessary for growth and the maintenance of life. The known essential vitamins may be divided into two categories. Vitamin C and the B- complex vitamins are called water soluble and are not stored in very large quantity in the body. The fat soluble vitamins include A, D, E, and K and are stored in greater quantities than the water soluble vitamins. The specific functions of the major vitamins are provided in Table 2. Note that vitamins are not an integral part of the cellular structure, nor are they a source of food energy. Therefore, athletes do not require greater quantities of vitamins than sedentary individuals. The one exception to this statement is thiamin, which is part of the B- complex. The Food and Nutrition Board of the National Research Council-National Academy of Sciences recommends that thiamin intake be increased as food energy intake increases. Athletes consuming greater quantities of food than sedentary individuals will, therefore, require a higher level of thiamin in the diet. Fortunately, thiamin is found in a variety of foods including pork, peas, beans, nuts, breads, and cereals, so that the athlete eating a varied diet will receive more thiamin as food intake increases.

Many athletes have adopted the practice of taking vitamin supplements. There is currently no justification for this practice and there is in fact a potential hazard. As previously stated, the fat soluble vitamins are stored in the body and consumption of large quantities of supplements can lead to toxic reaction. This problem is of particular concern with vitamins A and D. Consequently, the recommendation for athletes is to eat a variety of foods and vitamin requirements will be met without complications.

TABLE 2 - FUNCTIONS OF VITAMINS

Vitamin	Function
A	Essential for vision in dim light.

	Necessary for maintenance of healthy epithelial cells in skin and mucus secreting epithelial cells of the respiratory, gastrointestinal and genito urinary tracts.
D	Promotes calcification of bones and teeth.
E	Exact function of vitamin E is still unknown. This vitamin may help in protecting the fats in the body from being destroyed.
K	Assists in the normal blood clotting process.
C	Permits the formation of healthy collagen, which is responsible for binding cells together. Assists in the absorption of iron and calcium.
Thiamin (B_1)	Essential for the conversion of food to a form of energy that the body can use. Necessary for the normal functioning of the nervous system.
Riboflavin (B_2)	Contributes to the process of converting food to energy for the body's use.
Niacin	Necessary for conversion of food to energy. Involved in the synthesis of fat, protein and specific carbohydrates in the body.
Pyridoxine (B_6)	Essential for the metabolism of protein in the body. Needed for normal functioning of the central nervous system.
Folacin	Contributes to the formation of red blood cells and proteins.
Cobalamin (B_{12})	Necessary for normal growth. Assists in the maintenance of healthy nervous tissue. Essential for normal blood formation.

Minerals

Minerals are inorganic substances which are found in the earth's crust, some of which are considered to be essential to man. This category of nutrients can be divided into two sub-categories on the basis of amounts considered to be necessary for maintenance of health. The major or macro minerals are sodium, potassium, calcium, phosphorus, magnesium, sulfur and chlorine. These minerals are needed in quantities greater than 100 milligrams per day. Micro or trace minerals are needed in quantities less than this amount and include iron, copper, iodine, fluorine, zinc, chromium, cobalt, manganese, molybdenum and selenium.

The functions of minerals are three fold. They serve as integral components of specific tissues, for example the deposition of calcium and phosphorus in bones and teeth. Minerals are also incorporated into enzymes and hormones which help to regulate chemical reactions in the body. Lastly, minerals play an important role in regulating body processes that are not controlled by enzymes or hormones. Description of the individual functions of the majority of minerals is provided in Table 3.

Athletes consuming a varied diet including dairy products will receive adequate amounts of minerals to promote health and outstanding athletic performance. The only mineral that may be provided in suboptimal quantities is iron, if care is not taken to incorporate iron rich foods in the diet. All teenage and mature women experience an increase in the need for iron as a result of the onset of menarche. In addition, a condition known as sports anemia may further compound the iron requirement of female adolescents. Sports anemia is iron deficiency anemia and results primarily from loss of iron in sweat. The athlete participating in long endurance sports is the main candidate for this condition, although athletes competing in other types of sports have encountered the problem. Careful inclusion of iron rich foods in the diet, such as liver, egg yolk, spinach and dried fruit will usually act as a preventative measure or

remedy the situation if it is present. In extreme cases, a physician may be consulted to prescribe an iron supplement.

TABLE 3 - FUNCTIONS OF MINERALS

Mineral	Functions
Calcium	Contributes to the structure of bones and teeth. Permits normal blood clotting. Essential for muscular contraction. Needed for normal neural transmissions.
Phosphorus	Contributes to the structure of bones and teeth. Necessary for the controlled release of energy from protein, carbohydrate and fat.
Magnesium	Necessary for all reactions in the body that require the use of energy. Essential for muscular relaxation. Permits normal neural transmission.
Sodium	Maintains normal water balance. Needed for normal transmission of nerve impulses.
Potassium	Maintains normal water balance. Needed for normal transmission of nerve impulses. Essential for muscular relaxation.
Iron	Combines with compounds in the red blood cells to carry oxygen from the lungs to other tissues in the body.
Iodine	Regulates bodily growth and development. Regulates the rate of metabolism.
Zinc	Necessary for normal growth and gonadal development. Needed for normal taste acquity.

Water

The final nutrient of the six categories of essential nutrients is water. Fifty to 60 percent of the body weight of most individuals is water and

this nutrient has many important functions to perform. Water is considered to be a structural component of blood, it is the medium in which all the chemical reactions in the body take place and it contributes to the regulation of body temperature. This last role of water is particularly crucial to the athlete participating in rigorous activity in a warm environment.

Desirable water intake is about 2.5 quarts of water per day for an adult of normal body temperature living in a temperate climate. This water is supplied by foods and beverages, as well as drinking water. When a person is in water balance the 2.5 quarts of water consumed are offset with an equal loss of water through urine, feces, perspiration and exhaled air.

This balance of water and output is desirable and problems arise for the athlete who becomes dehydrated. Fatique and loss of strength are primary symptoms of mild dehydration and oppose all of the positive efforts the athlete has made for increasing strength and stamina. In more severe cases of dehydration, heat stroke and death may occur. These problems are unnecessary and emphasize the need for replacing water loss on an hourly basis as the athlete trains and competes. It should be noted that thirst may not always be relied upon to indicate to the athlete that water replacement is necessary. This point is particularly true for athletes competing in long endurance sports in very warm and dry climates, where water requirements may be high as 10 quarts per day.

Food Energy

The energy yielding nutrients include protein, carbohydrate and fat. The body must convert the food to a form of energy that it can use to support the growth process, physical activity and metabolic process that maintain life. Another energy yielding substance that may also be included in the diet is alcohol. Approximately 70 kilocalories of food energy are supplied by 10 grams of alcohol. Alcohol provides little else besides food energy in the diet.

The food energy requirements of moderately active females of varying ages are found in Table 4. The unit of measure for food energy is the kilocalorie and is a unit of heat which expresses the energy content of food. One kilocalorie is the amount of heat that is necessary to raise 4.2 cups of water one degree centigrade.

A person weighing 150 pounds requires 11 kilocalories per minute or 660 kilocalories per hour for the activity of swimming. Body weight influences the energy requirement for activity, so that a person weighing 120 pounds will require less energy to do the same activity than a 150 pound individual. Degree of muscular work also influences energy requirements. If two girls of equal weight swim for one hour, with one swimming two miles per hour and the other four miles per hour, the latter will require more energy to support that activity than the former.

Athletes participating in strenuous events will obviously require more food energy than the amounts which are suggest in Table 4. One simple recommendation is for athletes to eat until their appetites are satiated. This does not imply that they should stuff themselves with food until emotional satisfaction is attained, rather the absence of physical hunger should be the cue for cessation of eating. If body weight is not maintained within several pounds, the athlete may need to make a concerted effort to consume more foods that are concentrated sources of food energy.

TABLE 4 - RECOMMENDED DIETARY ALLOWANCES FOR FEMALES OF VARIOUS AGE GROUPS[1]

Nutrients	Age Groups (years)			
	7-10	11-14	15-18	19-22
Energy (kcal.)	2400	2400	2100	2100
Protein (g)	3[illegible]	44	48	46
Vitamin A (I.U.)	3300	4000	4000	4000
Vitamin D (I.U.)	400	400	400	400
Vitamin E (I.U.)	10	12	12	12
Vitamin C (mg)	40	45	45	45
Folacin (ug)	300	400	400	400

Nutrients	Age Groups (years)			
	7-10	11-14	15-18	19-22
Niacin (mg)	16	16	14	14
Riboflavin (mg)	1.2	1.3	1.4	1.4
Thiamin (mg)	1.2	1.2	1.1	1.1
Vitamin B_6 (mg)	1.2	1.6	2.0	2.0
Vitamin B_{12} (ug)	2.0	3.0	3.0	3.0
Calcium (mg)	800	1200	1200	800
Phosphorus (mg)	800	1200	1200	800
Iodine (ug)	110	115	115	100
Iron (mg)	10	18	18	18
Magnesium (mg)	250	300	300	300
Zinc (mg)	10	15	15	15

[1]Information for Table 4 was obtained from National Academy of Science, 1974, Eighth Edition. Recommended Dietary Allowances. Printing and Publishing Office, Washington, D.C.

Selecting the Diet

Now that the basic principles of nutrition have been discussed, they need to be applied to the selection of the diet. One method for selecting an adequate diet is to use the Recommended Dietary Allowances (RDA) proposed by the Food and Nutrition Board of the National Research Council-National Academy of Sciences. The RDA are levels of intake of essential nutrients considered to be adequate to meet the known nutritional needs of almost all healthy persons. Essential nutrient allowances for females of various age groups are provided in Table 4.

The RDA are intended for use with groups of people to ensure that a nutritionally sound diet is being provided. Nutritionists and dietitians do, however, use this tool in evaluating the nutritional content of individual diets. This method of evaluation is rather complex. In addition to the RDA, a food composition book must be employed, so that the intake of each nutrient may be calculated for the day.

A more feasible approach to dietary selection is the utilization of the Daily Food Guide. Foods of similar nutrient value are categorized into four groups

and numbers of servings from each group are suggested according to age. Information concerning the Daily Food Guide is provided in Table 5. When the appropriate number of servings are consumed from a variety of foods within the food groups, approximately 1200 kilocalories will be supplied. The remainder of the food energy requirement may be provided by additional servings from the food groups sauces, gravies, butter, margarine, jellies and other sweets. The athlete who uses the Daily Food Guide and selects servings from a variety of foods will be consuming a diet that will contribute to optimum athletic performance.

TABLE 5 - A DAILY FOOD GUIDE

Food Group and Serving Size	Number of Servings		
	Child	Teenager	Adult
Milk:	3	4	2
1 cup milk			
1 cup yogurt			
1½ oz. cheese			
Meat:	2	2	2
2-3 oz. cooked meat, fish, poultry			
4 tbsp. peanut butter			
2 eggs			
1 cup dried beans			
Fruit-Vegetable:	4	4	4
½ cup juice			
½ cup fruit, vegetable			
Bread-Cereal:	4	4	4
1 slice bread			
1 c. cold cereal			
½ c. cooked cereal, noodles, rice			

PARTICULAR DIETARY CONCERNS OF THE ATHLETE

Athletes are always striving to improve their performance by physical conditioning, mental discipline or "psyching" and dietary practices. Three specific dietary practices that may be of interest to the athlete are glycogen loading, weight gain or loss and the use of liquid dietary supplements.

Glycogen Loading

As you may recall, glycogen is the storage form of carbohydrate found in liver and muscle and is used as a source of energy during physical activity. A training technique known as carbohydrate loading or glycogen loading enables the athlete to increase glycogen stores by more than twice the amount that is normally found in muscle. This increased quantity of stored glycogen then allows the athlete to participate in endurance sports for longer periods of time with greater stamina.

Dietary selection and physical exercise must both be altered to increase glycogen stores. One week prior to competition, the athlete engages in strenous exercise and consumes a diet that is very high in protein and fat and limited in carbohydrate content. This procedure is continued for three days and causes a depletion of glycogen from muscle. On days four, five and six the diet is changed to include a large amount of carbohydrate and exercise is restricted to a light work out. This phase of the procedure causes repletion of glycogen in muscle that exceeds the quantity that would normally be present. On the day of competition or the seventh day of glycogen loading, the athlete may eat a well-balanced diet.

The advantage in utilizing this training technique is that performance in an endurance event may be prolonged; however, there is also a disadvantage. Extra water is deposited and stored in muscle as a result of the increased storage of glycogen. This extra water found in muscles may cause a feeling of stiffness and a loss of flexibility for the athlete.

Mention has been made of glycogen loading in this chapter primarily for clarification of the procedure, because many athletes misunderstand and misuse the technique. Synchronized swimmers perform routines that are approximately five minutes in duration and, therefore, would not receive any of the benefits of glycogen loading. This procedure is beneficial only to athletes participating in events that require at least 15 continuous minutes of physical exertion and should be used only two or three times a year for special competitions.

Weight Gain and Loss

Many athletes are concerned with attaining a body weight that is compatible with a high level of strength and endurance. Body weight is changed by simply altering energy balance, so that weight is lost by expending more energy than is consumed and weight is gained by consuming more food energy than is expended. Gaining or losing weight should be a gradual procedure with a maximum gain of one to two pounds a week.

One pound of body fat is equal to 3,500 kilocalories of food energy. An athlete wishing to lose two pounds in one week must expend 7,000 kilocalories of energy more than is consumed or 1,000 kilocalories per day. The level of exercise may be increased to account for an additional expenditure of 300 kilocalories and the remaining 700 kilocalories may be omitted from the diet. A teenage female athlete requiring about 2,800 kilocalories of food energy may then consume 2,100 kilocalories. This amount of food intake is sufficient to allow for the appropriate number of servings suggested in the Daily Food Guide (1,200 kilocalories), as well as for some fats and other condiments. If care is taken in selecting foods from the Daily Food Guide, the diet will supply adequate amounts of protein, vitamins and minerals to support optimum physical performance.

Weight gain in an athlete should be in the form of muscle and an additional 2,500 kilocalories of food energy must be consumed along with rigorous

exercise for one pound of body muscle to be gained. Adding 3,000 kilocalories of food energy to the diet per week or about 700 kilocalories per day will allow for a gain of two pounds of muscle if the athlete is training vigorously. The additional food energy may be supplied by extra servings from the Daily Food Guide and liberal usage of fats, condiments and desserts. The physical conditioning program that coincides with the extra food intake should always be supervised by the trainer or coach.

Liquid Dietary Supplements

Liquid supplements designed specifically for athletes are currently on the market and usually include protein, carbohydrate, fat, vitamins and minerals. These products may be useful in a variety of situations.

The athlete attempting to increase body weight may find that a dietary supplement is an easy way to increase food energy intake. Consumption of liquid supplements has also been found to be helpful in preventing weight loss in athletes who have a difficult time maintaining body weight during the competitive season. Liquid dietary supplements may occasionally be used in place of a meal, if time does not permit the preparation and consumption of food. Finally, many coaches have chosen to replace the traditional pregame meal with liquid dietary supplements. Use of these products before competition has been shown to relieve the nausea that many athletes experience just prior to and during the event.

An important point to remember is that the liquid supplements do not impart special nutrients that will improve athletic performance. These products are simply convenient substitutes for food when the athlete wishes to increase food energy intake or when time does not permit the consumption of a regular meal.

FACTS AND FALLACIES

Unfortunately, misinformation and superstition

are often the basis for the dietary selection of many athletes. The following section includes incorrect statements that are often made by competitive athletes and the corresponding corrections that must be made to these false statements.

Fallacy #1 - So called "quick energy" foods such as candy bars or honey should be eaten immediately before participating in sports of short duration such as synchronized swimming.
Fact - Foods must be digested and absorbed before they provide energy for physical activity. The honey that is eaten before competition simply sits in the stomach during the event and becomes useful to the athlete in the form of blood glucose only two to three hours after ingestion. Thus, consumption of "quick energy" foods before short duration sports is a worthless practice. It may alter blood plasma volume and blood potassium, and actually decrease muscle function.

Fallacy #2 - A big pre-event meal should be eaten two or three hours prior to competition.
Fact - Digestion of a traditional meal containing protein, carbohydrate and fat usually occurs within three to four hours of ingestion. However, when an athlete becomes excited and anxious in anticipation of competition, the digestive process is slowed down. Consequently, a large pre-event meal should be eaten five to six hours before competition so that the athlete's stomach is relatively empty and nausea is not experienced. One alternative to this pre-event strategy is to provide a light, high carbohydrate meal to the competitor three hours before the event. Carbohydrate is digested more quickly than protein and fat, and will not remain in the stomach as long a time.

Fallacy #3 - One or two meals a day is adequate for an athlete, if body weight is maintained.
Fact - Blood glucose is a fuel that athletes use to supply a source of energy for muscular work. The diet is a primary contributor of glucose for the bloodstream and meals should be eaten frequently to ensure an adequate supply of blood glucose is available for physical activity. Food intake should optimally be divided into

three meals and two snacks per day.

Fallacy #4 — Athletes require more protein than less active individuals and steak is the best source of protein.

Fact — Protein found in muscle is not used up or [illegible] during physical activity. Additional food energy is simply necessary to support the increased level of activity. In addition, eating large quantities of protein will not increase an athlete's muscle mass because protein is used as a source of food energy, once the protein needs of the body have been met. Steak is a good source of protein; however, there is nothing magical about this food that will improve an athlete's performance. Fish, poultry, pork, eggs, peanut butter and even beans are also good sources of protein that might be included in an athlete's diet.

Fallacy #5 — Protein and amino acid supplements should be consumed by athletes who wish to build up their muscles.

Fact — Protein and amino acid supplements are not necessary to supply protein for growth of new tissue because most Americans consume diets that are very ample in protein. Supplements are an expensive means of incorporating a small amount of protein in the diet.

Fallacy #6 — Candies, sweets, fats and fried foods should not be eaten when an athlete is in training.

Fact — Synchronized swimmers may have food energy requirements of 2,800 kilocalories or more per day depending upon age and the level of activity. As previously discussed, selection of foods according to the Daily Food Guide supplies approximately 1,200 kilocalories. Therefore, it is necessary for athletes to eat some foods that contain sugars and fats to consume the additional food energy that is required to support the increased level of physical activity.

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	Necessary for maintenance of healthy epithelial cells in skin and mucus secreting epithelial cells of the respiratory, gastrointestinal and genito urinary tracts.
D	Promotes calcification of bones and teeth.
E	Exact function of vitamin E is still unknown. This vitamin may help in protecting the fats in the body from being destroyed.
K	Assists in the normal blood clotting process.
C	Permits the formation of healthy collagen, which is responsible for binding cells together. Assists in the absorption of iron and calcium.
Thiamin (B_1)	Essential for the conversion of food to a form of energy that the body can use. Necessary for the normal functioning of the nervous system.
Riboflavin (B_2)	Contributes to the process of converting food to energy for the body's use.
Niacin	Necessary for conversion of food to energy. Involved in the synthesis of fat, protein and specific carbohydrates in the body.
Pyridoxine (B_6)	Essential for the metabolism of protein in the body. Needed for normal functioning of the central nervous system.
Folacin	Contributes to the formation of red blood cells and proteins.
Cobalamin (B_{12})	Necessary for normal growth. Assists in the maintenance of healthy nervous tissue. Essential for normal blood formation.

Minerals

Minerals are inorganic substances which are found in the earth's crust, some of which are considered to be essential to man. This category of nutrients can be divided into two sub-categories on the basis of amounts considered to be necessary for maintenance of health. The major or macro minerals are sodium, potassium, calcium, phosphorus, magnesium, sulfur and chlorine. These minerals are needed in quantities greater than 100 milligrams per day. Micro or trace minerals are needed in quantities less than this amount and include iron, copper, iodine, fluorine, zinc, chromium, cobalt, manganese, molybdenum and selenium.

The functions of minerals are three fold. They serve as integral components of specific tissues, for example the deposition of calcium and phosphorus in bones and teeth. Minerals are also incorporated into enzymes and hormones which help to regulate chemical reactions in the body. Lastly, minerals play an important role in regulating body processes that are not controlled by enzymes or hormones. Description of the individual functions of the majority of minerals is provided in Table 3.

Athletes consuming a varied diet including dairy products will receive adequate amounts of minerals to promote health and outstanding athletic performance. The only mineral that may be provided in suboptimal quantities is iron, if care is not taken to incorporate iron rich foods in the diet. All teenage and mature women experience an increase in the need for iron as a result of the onset of menarche. In addition, a condition known as sports anemia may further compound the iron requirement of female adolescents. Sports anemia is iron deficiency anemia and results primarily from loss of iron in sweat. The athlete participating in long endurance sports is the main candidate for this condition, although athletes competing in other types of sports have encountered the problem. Careful inclusion of iron rich foods in the diet, such as liver, egg yolk, spinach and dried fruit will usually act as a preventative measure or

remedy the situation if it is present. In extreme cases, a physician may be consulted to prescribe an iron supplement.

TABLE 3 - FUNCTIONS OF MINERALS

Mineral	Functions
Calcium	Contributes to the structure of bones and teeth. Permits normal blood clotting. Essential for muscular contraction. Needed for normal neural transmissions.
Phosphorus	Contributes to the structure of bones and teeth. Necessary for the controlled release of energy from protein, carbohydrate and fat.
Magnesium	Necessary for all reactions in the body that require the use of energy. Essential for muscular relaxation. Permits normal neural transmission.
Sodium	Maintains normal water balance. Needed for normal transmission of nerve impulses.
Potassium	Maintains normal water balance. Needed for normal transmission of nerve impulses. Essential for muscular relaxation.
Iron	Combines with compounds in the red blood cells to carry oxygen from the lungs to other tissues in the body.
Iodine	Regulates bodily growth and development. Regulates the rate of metabolism.
Zinc	Necessary for normal growth and gonadal development. Needed for normal taste acquity.

Water

The final nutrient of the six categories of essential nutrients is water. Fifty to 60 percent of the body weight of most individuals is water and

this nutrient has many important functions to perform. Water is considered to be a structural component of blood, it is the medium in which all the chemical reactions in the body take place and it contributes to the regulation of body temperature. This last role of water is particularly crucial to the athlete participating in rigorous activity in a warm environment.

Desirable water intake is about 2.5 quarts of water per day for an adult of normal body temperature living in a temperate climate. This water is supplied by foods and beverages, as well as drinking water. When a person is in water balance the 2.5 quarts of water consumed are offset with an equal loss of water through urine, feces, perspiration and exhaled air.

This balance of water and output is desirable and problems arise for the athlete who becomes dehydrated. Fatigue and loss of strength are primary symptoms of mild dehydration and oppose all of the positive efforts the athlete has made for increasing strength and stamina. In more severe cases of dehydration, heat stroke and death may occur. These problems are unnecessary and emphasize the need for replacing water loss on an hourly basis as the athlete trains and competes. It should be noted that thirst may not always be relied upon to indicate to the athlete that water replacement is necessary. This point is particularly true for athletes competing in long endurance sports in very warm and dry climates, where water requirements may be high as 10 quarts per day.

Food Energy

The energy yielding nutrients include protein, carbohydrate and fat. The body must convert the food to a form of energy that it can use to support the growth process, physical activity and metabolic process that maintain life. Another energy yielding substance that may also be included in the diet is alcohol. Approximately 70 kilocalories of food energy are supplied by 10 grams of alcohol. Alcohol provides little else besides food energy in the diet.

The food energy requirements of moderately active females of varying ages are found in Table 4. The unit of measure for food energy is the kilocalorie and is a unit of heat which expresses the energy content of food. One kilocalorie is the amount of heat that is necessary to raise 4.2 cups of water one degree centigrade.

A person weighing 150 pounds requires 11 kilocalories per minute or 660 kilocalories per hour for the activity of swimming. Body weight influences the energy requirement for activity, so that a person weighing 120 pounds will require less energy to do the same activity than a 150 pound individual. Degree of muscular work also influences energy requirements. If two girls of equal weight swim for one hour, with one swimming two miles per hour and the other four miles per hour, the latter will require more energy to support that activity than the former.

Athletes participating in strenuous events will obviously require more food energy than the amounts which are suggest in Table 4. One simple recommendation is for athletes to eat until their appetites are satiated. This does not imply that they should stuff themselves with food until emotional satisfaction is attained, rather the absence of physical hunger should be the cue for cessation of eating. If body weight is not maintained within several pounds, the athlete may need to make a concerted effort to consume more foods that are concentrated sources of food energy.

TABLE 4 - RECOMMENDED DIETARY ALLOWANCES FOR FEMALES OF VARIOUS AGE GROUPS[1]

Nutrients	Age Groups (years)			
	7-10	11-14	15-18	19-22
Energy (kcal.)	2400	2400	2100	2100
Protein (g)	3[illegible]	44	48	46
Vitamin A (I.U.)	3300	4000	4000	4000
Vitamin D (I.U.)	400	400	400	400
Vitamin E (I.U.)	10	12	12	12
Vitamin C (mg)	40	45	45	45
Folacin (ug)	300	400	400	400

Nutrients	Age Groups (years)			
	7-10	11-14	15-18	19-22
Niacin (mg)	16	16	14	14
Riboflavin (mg)	1.2	1.3	1.4	1.4
Thiamin (mg)	1.2	1.2	1.1	1.1
Vitamin B_6 (mg)	1.2	1.6	2.0	2.0
Vitamin B_{12} (ug)	2.0	3.0	3.0	3.0
Calcium (mg)	800	1200	1200	800
Phosphorus (mg)	800	1200	1200	800
Iodine (ug)	110	115	115	100
Iron (mg)	10	18	18	18
Magnesium (mg)	250	300	300	300
Zinc (mg)	10	15	15	15

[1]Information for Table 4 was obtained from National Academy of Science, 1974, Eighth Edition. Recommended Dietary Allowances. Printing and Publishing Office, Washington, D.C.

Selecting the Diet

Now that the basic principles of nutrition have been discussed, they need to be applied to the selection of the diet. One method for selecting an adequate diet is to use the Recommended Dietary Allowances (RDA) proposed by the Food and Nutrition Board of the National Research Council-National Academy of Sciences. The RDA are levels of intake of essential nutrients considered to be adequate to meet the known nutritional needs of almost all healthy persons. Essential nutrient allowances for females of various age groups are provided in Table 4.

The RDA are intended for use with groups of people to ensure that a nutritionally sound diet is being provided. Nutritionists and dietitians do, however, use this tool in evaluating the nutritional content of individual diets. This method of evaluation is rather complex. In addition to the RDA, a food composition book must be employed, so that the intake of each nutrient may be calculated for the day.

A more feasible approach to dietary selection is the utilization of the Daily Food Guide. Foods of similar nutrient value are categorized into four groups

and numbers of servings from each group are suggested according to age. Information concerning the Daily Food Guide is provided in Table 5. When the appropriate number of servings are consumed from a variety of foods within the food groups, approximately 1200 kilocalories will be supplied. The remainder of the food energy requirement may be provided by additional servings from the food groups sauces, gravies, butter, margarine, jellies and other sweets. The athlete who uses the Daily Food Guide and selects servings from a variety of foods will be consuming a diet that will contribute to optimum athletic performance.

TABLE 5 - A DAILY FOOD GUIDE

Food Group and Serving Size	Number of Servings		
	Child	Teenager	Adult
Milk: 1 cup milk 1 cup yogurt 1½ oz. cheese	3	4	2
Meat: 2-3 oz. cooked meat, fish, poultry 4 tbsp. peanut butter 2 eggs 1 cup dried beans	2	2	2
Fruit-Vegetable: ½ cup juice ½ cup fruit, vegetable	4	4	4
Bread-Cereal: 1 slice bread 1 c. cold cereal ½ c. cooked cereal, noodles, rice	4	4	4

PARTICULAR DIETARY CONCERNS OF THE ATHLETE

Athletes are always striving to improve their performance by physical conditioning, mental discipline or "psyching" and dietary practices. Three specific dietary practices that may be of interest to the athlete are glycogen loading, weight gain or loss and the use of liquid dietary supplements.

Glycogen Loading

As you may recall, glycogen is the storage form of carbohydrate found in liver and muscle and is used as a source of energy during physical activity. A training technique known as carbohydrate loading or glycogen loading enables the athlete to increase glycogen stores by more than twice the amount that is normally found in muscle. This increased quantity of stored glycogen then allows the athlete to participate in endurance sports for longer periods of time with greater stamina.

Dietary selection and physical exercise must both be altered to increase glycogen stores. One week prior to competition, the athlete engages in strenous exercise and consumes a diet that is very high in protein and fat and limited in carbohydrate content. This procedure is continued for three days and causes a depletion of glycogen from muscle. On days four, five and six the diet is changed to include a large amount of carbohydrate and exercise is restricted to a light work out. This phase of the procedure causes repletion of glycogen in muscle that exceeds the quantity that would normally be present. On the day of competition or the seventh day of glycogen loading, the athlete may eat a well-balanced diet.

The advantage in utilizing this training technique is that performance in an endurance event may be prolonged; however, there is also a disadvantage. Extra water is deposited and stored in muscle as a result of the increased storage of glycogen. This extra water found in muscles may cause a feeling of stiffness and a loss of flexibility for the athlete.

Mention has been made of glycogen loading in this chapter primarily for clarification of the procedure, because many athletes misunderstand and misuse the technique. Synchronized swimmers perform routines that are approximately five minutes in duration and, therefore, would not receive any of the benefits of glycogen loading. This procedure is beneficial only to athletes participating in events that require at least 15 continuous minutes of physical exertion and should be used only two or three times a year for special competitions.

Weight Gain and Loss

Many athletes are concerned with attaining a body weight that is compatible with a high level of strength and endurance. Body weight is changed by simply altering energy balance, so that weight is lost by expending more energy than is consumed and weight is gained by consuming more food energy than is expended. Gaining or losing weight should be a gradual procedure with a maximum gain of one to two pounds a week.

One pound of body fat is equal to 3,500 kilocalories of food energy. An athlete wishing to lose two pounds in one week must expend 7,000 kilocalories of energy more than is consumed or 1,000 kilocalories per day. The level of exercise may be increased to account for an additional expenditure of 300 kilocalories and the remaining 700 kilocalories may be omitted from the diet. A teenage female athlete requiring about 2,800 kilocalories of food energy may then consume 2,100 kilocalories. This amount of food intake is sufficient to allow for the appropriate number of servings suggested in the Daily Food Guide (1,200 kilocalories), as well as for some fats and other condiments. If care is taken in selecting foods from the Daily Food Guide, the diet will supply adequate amounts of protein, vitamins and minerals to support optimum physical performance.

Weight gain in an athlete should be in the form of muscle and an additional 2,500 kilocalories of food energy must be consumed along with rigorous

are often the basis for the dietary selection of many athletes. The following section includes incorrect statements that are often made by competitive athletes and the corresponding corrections that must be made to these false statements.

Fallacy #1 - So called "quick energy" foods such as candy bars or honey should be eaten immediately before participating in sports of short duration such as synchronized swimming.
Fact - Foods must be digested and absorbed before they provide energy for physical activity. The honey that is eaten before competition simply sits in the stomach during the event and becomes useful to the athlete in the form of blood glucose only two to three hours after ingestion. Thus, consumption of "quick energy" foods before short duration sports is a worthless practice. It may alter blood plasma volume and blood potassium, and actually decrease muscle function.

Fallacy #2 - A big pre-event meal should be eaten two or three hours prior to competition.
Fact - Digestion of a traditional meal containing protein, carbohydrate and fat usually occurs within three to four hours of ingestion. However, when an athlete becomes excited and anxious in anticipation of competition, the digestive process is slowed down. Consequently, a large pre-event meal should be eaten five to six hours before competition so that the athlete's stomach is relatively empty and nausea is not experienced. One alternative to this pre-event strategy is to provide a light, high carbohydrate meal to the competitor three hours before the event. Carbohydrate is digested more quickly than protein and fat, and will not remain in the stomach as long a time.

Fallacy #3 - One or two meals a day is adequate for an athlete, if body weight is maintained.
Fact - Blood glucose is a fuel that athletes use to supply a source of energy for muscular work. The diet is a primary contributor of glucose for the bloodstream and meals should be eaten frequently to ensure an adequate supply of blood glucose is available for physical activity. Food intake should optimally be divided into

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Fact - Protein found in muscle is not used up or [illegible] during physical activity. Additional food energy is simply necessary to support the increased level of activity. In addition, eating large quantities of protein will not increase an athlete's muscle mass because protein is used as a source of food energy, once the protein needs of the body have been met. Steak is a good source of protein; however, there is nothing magical about this food that will improve an athlete's performance. Fish, poultry, pork, eggs, peanut butter and even beans are also good sources of protein that might be included in an athlete's diet.

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Fact - Protein and amino acid supplements are not necessary to supply protein for growth of new tissue because most Americans consume diets that are very ample in protein. Supplements are an expensive means of incorporating a small amount of protein in the diet.

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WEIGHT TRAINING GLOSSARY

AEROBIC - In the presence of oxygen.
ANAEROBIC - In the absence of oxygen.
FLEXIBILITY - Range of motion of a joint.
INTERVAL TRAINING - Is short but repeated bouts of exercise with adequate relief periods.
ISOKINETIC CONTRACTION - Muscular effort that is maximal over the entire range of motion.
ISOMETRIC CONTRACTION - Muscular effort which does not result in joint movement; the force does not move the resistance.
ISOTONIC CONTRACTION - Muscular effort that results in joint movement due to the shortening of the contracting muscle tissue.
MAXIMUM STRENGTH - Amount of force that an individual can produce in one contraction.
OXYGEN DEBT - Amount of oxygen consumed during recovery in excess of that during a normal rest interval.
RELIEF PERIOD - There should be a minimum of 24 hours and a maximum of 48 hours between work-outs.
WEIGHT TRAINING FREQUENCY - Maximal is three times per week, minimal is twice per week.
WORKOUT WEIGHT - Maximum lift times 70%.

WEIGHT TRAINING FOR THE SYNCHRONIZED SWIMMER

Mary Jo Ruggieri, PhD
June Hart, BS, CAT

Training techniques for the synchronized swimmer have become very progressive in recent years. For an athlete to become one of the best in her sport, she must be trained better than the best in her field. Muscular strength is one of the more important variables in a well balanced program.

Strength training is very demanding and requires self-discipline. Supervision of the lifting is important for motivation, for safety and for working the athlete to her maximum. Whether the athlete works with free weights, universal gym or nautilus, all of the concepts that will be stressed in this article will apply to each area.

There are many reasons why a female should work on muscular strength. Primarily, it provides the power needed in basic movements by improving the diameter of the muscle fibers and the size of connective tissue. This concept also plays an important part in the prevention of injuries that might normally occur if the athlete were not properly trained. Weight training will also improve endurance so that the muscles can work longer without fatigue setting in so rapidly. Another factor is that flexibility improves with the pre-stretching prior to working on the weights. Accordingly, in strength training by increasing the muscle fiber size the percentage of body fat will decrease. The advantages of weight training have become so important to most athletes that many coaches feel it is the most necessary part to any program next to skill techniques.

Fox and Matthews report that the strength of a muscle that results from weight training is due to an increase in the cross-sectional area of the individual muscle fibers.[1] This is further supported by M. Ikai and T. Fukunoga who demonstrated the relationship between cross-sectional area and the strength of a muscle.[2] As the belly of the muscle increases so does the tendon which attach it to the bone. The increase in tendon size helps to prevent oculsions of the bone on a strong contraction. The muscle

strength and increased tendon size aid in supporting joints to give more stability. This was demonstrated with two Ohio State Synchronized Swimmers on the 1978-79 squad. With previous histories of ligamentous sprain and patellar dislocation the two swimmers concentrated efforts on strengthening the quadriceps and hamstrings. Few knee problems resulted after ten weeks of weight training. (Hart, Ruggieri) In essence, ligaments and tendons become stronger with weight training which provides a greater degree of protection to the joints.

Body composition changes following a weight training program will consist of 1. little or no change in total body weight; 2. significant losses of relative and absolute body fat; and 3. a significant gain in lean body weight. Throughout the six month strength training program of the Women's Synchronized Swim Team at The Ohio State University, four underwater weighings were done to determine the percent of body fat.

The pounds of fat, lean body mass, percent of body fat, density in relation to water and underwater weight were charted and correlated with the individual weight training charts. There is an indication, according to these particular team results, that as the strength gains increase the percentage of body fat decreases (Hart, Ruggieri).

Basic misconceptions of girls and women weight training need to be discussed. Since the female does not have the testosterone level of the male, it is not possible to develop the big, buldging muscles often associated with lifting weights.

The development of the muscles do change due to hypertrophy. As the muscle groups hypertrophy the fatty tissue is replaced with firm muscle tissue. The female will actually lose inches on a weight training program. The statistics kept on the Ohio State squad, demonstrated that the upper torso and waist decreased from one to three inches throughout a six month period. The athletes noted body changes of soft areas firming and the shape of their figure

improving.

General concepts of weight training for girls and women need to be established. The program should be designed specifically for the sport and then for the individual athletes. Training on weights may begin at approximately twelve years of age if supervised properly.

The principle of overloading is a primary concept that must be practiced at all times. The principle stated simply is the strength, endurance and hypertrophy of a muscle will increase only when the muscle performs for a given period of time at its maximal strength and endurance capacity.[3] This must be progressive in nature and the work of the muscle must be increased throughout the program. The system of progressive resistive exercise will show increases in strength after three weeks. Due to the overloading principle, muscles must be given rest on a planned schedule. For an example, lifting could occur three days per week for three weeks and then take one week off. This is not for the purpose of eliminating muscle soreness but to rest the muscles and give them a chance to build tissue. It is also to the advantage of the athlete to have one to two days between lifts so that fatigue doesn't set in.

Designing the weight program specifically for the sport is very important. The muscle groups must be evaluated to determine their relative function to the skills involved in the sport. This gives added strength to the skill performance when muscles are isolated and strength training applied. For an example, support sculling requires primary muscles of the forearm and wrists to perform efficiently. When these muscles are worked, the strength in support sculling shows improvement. Included in the appendix of this article is an analysis of muscle actions as used on the universal gym and applied to synchronized swimming skills. If the athlete is using free weights some of the movements are exactly the same. Any athlete or coach should know what muscle groups are being used at which stations when lifting, therefore, if a swimmer has a weak area, she can be guided to work

more on that specific problem. Individual programs should be designed to allow for differences in strength and endurance. All of the exercises performed for the whole body are the same in any weight training program, but some muscles may require more work on some swimmers. When this occurs, the program should be modified to allow the athlete to overcome her weaknesses first and then accelerate the total program later.

To determine the type of weight training program that should be set up for the synchronized swimmer some specific details must be discussed. Defining the four types of muscle contractions will help in deciding the type of program needed for the athlete.

Isotonic - the muscle shortens with varying tension while lifting a constant load. An example would be free weights and Universal gym.

An Isotonic program is progressive resistive exercise. It involves determining the maximum that can be lifted and work 70% of that maximum at 8-12 repetitions or working three sets of ten with set one at ½ maximum, set two at 3/4 maximum. The method taught by this author is to work 70% of maximum at 8-12 repetitions. (To find maximum - the athlete lifts, on each station, as much as she can handle to be able to complete one cycle.) The rule applied here is a low repetitions and high loads build the desired strength. This type of contraction works through the range of motion to develop strength in all degrees of muscle contraction.

Isometric - develops tension in the muscle but there is no change in the length of the muscle. An example would be pushing an arm against the doorway holding 6 seconds, relax and repeat.

An Isometric program does build strength but only at the angle the muscle is worked. An isometric contraction with the elbow flexed to 90° strengthens the muscles only at 90° and at no other point is the muscle strengthened. If the skill requires a fixed

point of contraction this program is very good. The synchronized swimmer could use isometrics as part of their total program especially if they are using free weights and have set up work stations. One constructive point about doing isometrics is that the athlete should always exhale while doing the sets. This will help avoid building too much intrathoracic pressure. A typical set for an isometric would be (4-10) 6 second contractions with a 15 second rest between them.

Eccentric - the muscle lengthens while contracting developing tension. An example would be concentrating on the lowering of the weight after the lifting.

An eccentric contraction program is not used very often in the over-all program. It does show strength gains but it is not as popular. At this time it is used most in rehabilitating athletes following injury.

Isokinetic - the tension developed by the muscle while shortening is maximal over the entire movement or through the full range of motion of the movement. An example would be Nautilus, mini gym and cybex.

Isokinetic contraction will develop the greatest increase in muscle strength. More muscle bundles are brought in to use in this type of contraction which develops more over all strength. This also allows for more overload than the three previous mentioned programs. Another factor involved in isokinetic is that these machines can duplicate many of the movements used in the water to give maximum benefit to the dry land training program. Not all teams have access to this type of equipment, therefore, a solid program using free weights or universal gym plus controlled stretching before and after lifting would be a good program.

Below are twelve specific rules that should apply to any weight training program used by the synchronized swimmer: (Universal Gym)

1. Fifteen minutes of general stretching exercises must precede each workout.
2. Be sure pin is securely fastened in machine.
3. Use a lift cadence of Up 2, 3, 4 and Down 2, 3, 4. Pause at the top of the lift to secure weight.
4. Be sure you are in the correct body position and the correct body alignment for each lift. This will insure that you are using the proper muscles and help to prevent injuries.
5. Lift between 8-12 repetitions on each machine except where indicated. If you can do more than 12 go up one plate. Perform a minimum of 8 repetitions.
6. Each exercise should be performed to physical exhaustion. When you think you can't go one more push yourself a little harder. Overload principle must be used!
7. Breathing: Blow out on the lift "as if you are blowing the weight up."
8. Work on the machines according to muscle groups: 1st legs, 2nd stomach, 3rd back, 4th shoulders. Work large muscle groups first.
9. Don't lift with a cold or congestion. Remember breathing is important.
10. Lift 2-3 times per week (three is best) 24-48 hours rest between lifts. Lift for three weeks and rest one week.
11. Do weights for an entire season.
12. Always make sure you are supervised properly when first starting the season. A buddy system is best for all lifting. Keep an accurate record of all lifts daily!

Any weight raining program can be adapted to the seasonal progression in the sport. The first two weeks should be spent working the athletes through the stations without weights to check form and technique. During this time maximum lift should be tested on each station and recorded on a chart. Keeping a log helps the athlete and the coach know the weight that is being lifted at any particular day and how many repetitions are being completed. After the

maximum lift is tested, 70% of that is the weight to begin workouts with. The 70% is continued through the pre-season rechecking maximum every three weeks. When the early competitive season begins 80% of maximum is used to further develop the strength. Four to six weeks before Nationals the lifting is lessened. It is recommended to reduce to 50% of maximum and work two sets of 8-12 repetitions. The week before Nationals the weights should be stopped to allow for complete rest.

In conclusion, a well organized weight training program can benefit the synchronized swimmer. Strength training is very demanding but the benefits will outweigh the time and effort. The primary benefit is that the program will provide the muscular power needed to overcome the strenuous water training the synchronized swimmer must go through. The body composition changes that result from weight training, also enhance the toned look of the swimmer. It must be remembered that a good program is supervised, and well documented. The training, to be successful, must be done from pre-season to the taper before Nationals.

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1. Fox, E., Mathews, D.K., The Physiological Basis of Physical Education and Athletics, 2nd Ed., W.B. Saunders, 1976, pp. 139-40.

2. Fox, E., Mathews, D.K., The Physiological Basis of Physical Education and Athletics, 2nd Ed., W.B. Saunders, 1976, p. 137.

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UNIVERSAL GYM ANALYSIS CHART
FOR SYNCHRONIZED SWIMMERS

#1 MACHINE = Leg Extension
BODY POSITION - Sitting position, hands support at hips, feet hooked under pads
MOVEMENT - Legs extended, do not lock knees, release down
MUSCLES USED - Quadriceps
REPETITIONS - 8-12
PURPOSE = Ballet leg movements, leg extension, ankle strength

#2 MACHINE = Leg Curls
BODY POSITION = Lay on stomach, hands support on bars above head, hook heels under pads.
MOVEMENT - Lift weights up to buttocks and release.
MUSCLES USED = Hamstrings
REPETITIONS = 8-12
PURPOSE = Ballet leg movements, ankle strength

#3 MACHINE = Leg Press
BODY POSITION = Sitting position, hands supported under hips
MOVEMENT = Extend legs to straight but unlocked position and release
MUSCLES USED = Hamstrings and Quads
REPETITIONS = 8-12
PURPOSE = Ballet leg movements, ankle strength, leg extension

#4 MACHINE = Slant Board, Bent knee sit ups
BODY POSITION = Lay on back, knees bent, toes under pads, hands behind head
MOVEMENT = Sit up to vertical, down
MUSCLES USED = Abdominal group, rectus abdominis, external and internal oblique.
REPETITIONS = 8-12
PURPOSE = Thrusting, unrolling and lifting movements, double ballet legs.

#5 MACHINE - Slant Board, straight leg raises
BODY POSITION - On back, head up, hands hold rungs above head, legs straight
MOVEMENT - Lift legs straight up to 90° and down
MUSCLES USED - Abdominals
REPETITIONS - 8-12
PURPOSE - Thrusting, unrolling and lifting movements, double ballet leg

#6 MACHINE - Hip Flexors, Bent knee
BODY POSITION - Vertical position, support weight on arms 90° angle, legs straight, arms against pad
MOVEMENT - Lift legs up to bent knee to chest and down
MUSCLES USED - Psoas illiacus, rectus femorus
REPETITIONS - 8-12
PURPOSE - Vertical, tuck bent knee, pike position forearm strength for support sculling

#7 MACHINE - Hip Flexors, Straight leg
BODY POSITION - Same as #6
MOVEMENT - Straight lift, legs to 90° and hold 5 counts and down
MUSCLES USED - Illiopsoas, rectus femorus, quads
REPETITIONS - 5 lifts for 5 second counts
PURPOSE - Same as #6 - Isometric

#8 MACHINE - Hip Flexors Pike
BODY POSITION - Same as #6
MOVEMENT - Tuck, pike, tuck, down
MUSCLES USED - Same as #7
REPETITIONS - 8-12
PURPOSE - Same as #6 - Isometric

#9 MACHINE - Hip Flexors Crane
BODY POSITION - Same as #6
MOVEMENT - Bent knee to crane to bent knee to vertical
MUSCLES USED - Same as #7
REPETITIONS - 8-12
PURPOSE - Same as #6 - Isometric

#10 MACHINE - Back Hyperextension
BODY POSITION - Sitting position, toes hooked under pads, hands at side
MOVEMENT - Hands move to back of head, back arches to back bend position
MUSCLES USED - Deep posterior group
REPETITIONS - 8-12
PURPOSE - Arch movements - swordfish, walkovers etc., split positions

#11 MACHINE - Lower Back Extension
BODY POSITION - On stomach, legs straight out behind hands on pads
MOVEMENT - a. leg up and other leg up
b. both legs up
MUSCLES USED - Hamstrings
REPETITIONS - a. 12 times, b. 12 times
PURPOSE - Arch movements, tip up movements

#12 MACHINE - Chest Press
BODY POSITION - On back knees bent on board, hands in middle on bars
MOVEMENT - Lift and extend arms, do not lock elbows
MUSCLES USED - Ant. deltoid, triceps
REPETITIONS - 8-12
PURPOSE - All sculling strength, vertical position

#13 MACHINE - Shoulder Press
BODY POSITION - Sit facing out, line up shoulders under bar, hands on middle of bar
MOVEMENT - Extend arms up and straight, do no lock elbows
MUSCLES USED - Same as #12
REPETITIONS - 8-12
PURPOSE - Sculling, twists and spins, vertical position.

#14 MACHINE - Lat Pulldown Standing
BODY POSITION - Standing position, arms straight out, hands grasp handles
MOVEMENT - Pull arms straight down as far as possible and release up
MUSCLES USED - Latissimus vs. Dorsi Teres pect. maj.
REPETITIONS - 8-12
PURPOSE - Sculling, scull downs, spins, unrolling movement

#15 MACHINE - Lat Pulldown Sitting
BODY POSITION - Sitting on stool, face machine, hands grasp handles
MOVEMENT - Same as #14
MUSCLES USED - Latissimus, Dorsi Teres Maj, Pec. maj.
REPETITIONS - 8-12
PURPOSE - Same as #14

#16 MACHINE - Reverse Lat Pulldown
BODY POSITION - Sitting on stool, face out, grasp handles behind back
MOVEMENT - Pull down behind back and release up
MUSCLES USED - Pect. maj., Teres maj., Latissimus Dorsi
REPETITIONS - 8-12
PURPOSE - Same as #14

#17 MACHINE - Biceps Curl Up
BODY POSITION - Standing arms straight, hands facing up on bar
MOVEMENT - Pull bar to chest and release
MUSCLES USED - Biceps
REPETITIONS - 8-12
PURPOSE - Any arm action, support sculling

#18 MACHINE - Tricep Curl Up
BODY POSITION - Standing arms straight, hands facing down on bar
MOVEMENT - Lift bar up to chin, elbows out
MUSCLES USED - Tri Deltoid anterior
REPETITIONS - 8-12 with each action
PURPOSE - Same as #17

#19 MACHINE - Leg Swing
BODY POSITION - Ankle cuff on, ankle side to machine, hand grasps bar on machine
MOVEMENT - Swing leg across body and back (12 times) same leg, other side to machine and repeat; repeat with other leg
MUSCLES USED - All inward leg muscles
REPETITIONS - 8-12 with each action
PURPOSE - Ankle strength, split position, walkouts

#20 MACHINE - Chinning (Hands Over)
BODY POSITION - Hang, legs straight, hands over handles
MOVEMENT - Chin up as far as possible
MUSCLES USED - Triceps, Terpes major
REPETITIONS - 12
PURPOSE - Sculling, back strength for unrolls

#21 MACHINE - Chinning (Hands Under)
BODY POSITION - Hang, legs straight, hands under handles
MOVEMENT - Chin up as far as possible
MUSCLES USED - Biceps
REPETITIONS - 12
PURPOSE - Sculling, back strength

#22 MACHINE - Dipping
BODY POSITION - Hang, legs straight, hands face down, arms straight
MOVEMENT - Lower weight slowly down and push up
MUSCLES USED - Triceps
REPETITIONS - 12
PURPOSE - Sculling, back strength, upper body position strength

#23 MACHINE - Wrist Roller Flexion Extension
BODY POSITION - Standing hands over roller, face down
MOVEMENT - Turn roller forward as far as possible
MUSCLES USED - Flexor carpi, radialis, ulnaris
REPETITIONS - 12 turns
PURPOSE - Support sculling, sustained max. height

24 MACHINE - Wrist Roller Abduction
BODY POSITION - Standing, hands on ends of roller
MOVEMENT - Turn roller towards you as far as possible
MUSCLES USED - Flexor cardi, radialis and ulnaris
REPETITIONS - 12 turns
PURPOSE - Same as #23

25 MACHINE - Wrist Roller Provation
BODY POSITION - Standing, one hand on end of roller, face back of hand
MOVEMENT - Turn hand to right 12 turns, then to left 12 turns, repeat with other hand
MUSCLES USED - Supinator
REPETITIONS - 12 turns
PURPOSE - Same as #23

26 MACHINE - Handgripper
BODY POSITION - Standing, hands over grip
MOVEMENT - Press with right hand, then left hand
MUSCLES USED - Flexor wrist and extensors
REPETITIONS - 12 presses (1 right, 1 left = 1 press)
PURPOSE - Same as #23

27 MACHINE - Handgripper (Underhand)
BODY POSITION - Standing, hands under grip
MOVEMENT - Press with right hand, then left hand
MUSCLES USED - Same as #26
REPETITIONS - 12 presses (1 right, 1 left= 1 press)
PURPOSE - Same as #23

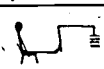
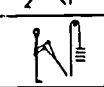
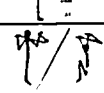
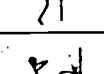
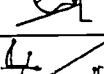
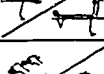
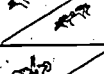
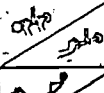
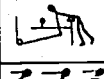
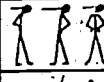
28 MACHINE - Neck Pull
BODY POSITION - Standing face machine, put brace on head, hands grasp machine poles
MOVEMENT - Extend head back, release; tuck chin in on pull back
MUSCLES USED - Stienocle domastoin erector spinae group, semispinalis
REPETITIONS - 8-12
PURPOSE - Vertical position, unrolling head movement

#29 MACHINE - TOE RAISES
BODY POSITION - Sitting position, hands supported under hips
MOVEMENT - Extend legs to straight point, toes relax, repeat
MUSCLES USED - Ankle extensors
REPETITIONS - 8-12
PURPOSE - Ballet leg, ankle extension

SAMPLE CHART UNIVERSAL GYM

NAME _____ AGE _____ CLASS _____

SCHOOL _____ COACH _____

CHEST PRESS 12	WIDE / REG			LB / REP / SET
LEG PRESS 3				LB / REP / SET
SHOULDER PRESS 13	BACK / FRONT			LB / REP / SET
PULLEY CHINS 14-16	BACK / FRONT			LB / REP / SET
TOE RAISES 29				LB / REP / SET
POSTURE ROW	TWO ARMS / ONE ARM			LB / REP / SET
ARM CURLS 17				LB / REP / SET
TRI EXTENSION 18				LB / REP / SET
CHINNING 20-21				REP / SET
HIP FLEXORS 6-9				
DIPPING 22				REP / SET
SIT UPS 21				POS / REP / SET
LEG EXTENSION				LB / REP / SET
2 LEG CURLS				
HAND GRIPPING 26,27	OVER / UNDER			LB / REP / SET
WRIST & FOREARM 23-25	Flexion / Extension / Pronation / Supination			RES / REP / SET
BACK ARCHES 11				LB / SET / REP / SET
SWIMMERS FLUTTER KICK				
SWIMMERS CHEST STROKE				LB / REP / SET
NECK EXERCISE 28	FRONT / BACK / EACH SIDE			LB / REP / SET
REAL RUNNING	Driving Position / Speed Position			RES / REP / SET

SAMPLE CHART NAUTILUS

Name

Date

EXERCISE	WT	REPS	WT	REPS
1. a. Leg Extension				
b. Leg Press				
c. Leg Curl				
d. Hip and Back				
2. a. Pullover				
b. Torso/Arm				
3. a. Pectoral				
b. Bench Press				
4. a. Lateral Raise				
b. Behind-Neck Press				
5. Rowing				
6. Biceps				
7. Wrist				
8. Sit-ups				
9. Sit-ups Legs				
10. Other:				

CIRCUIT STRENGTH TRAINING PROGRAM FOR SYNCHRONIZED SWIMMERS

Mary Jo Ruggieri, PhD
Mary Raipa

Weight training programs are becoming an integral part of the conditioning regimes for our girl and women athletes. Teams and individuals that have access to the Universal and Nautilus weight (strength) training equipment are able to incorporate functional strength building exercises into their daily schedules. But what about those athletes who do not have access to such elaborate and expensive machines? With a minimum of equipment and a little creativity athletes and coaches can devise their own strength training programs.

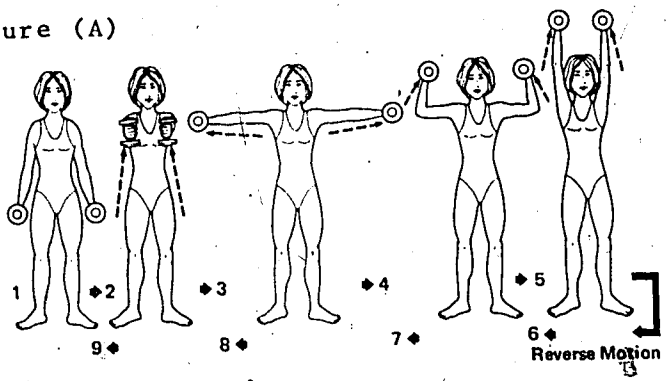
Below are some strength building exercises that were designed specifically for the elite synchronized swimmer at the Olympic Training Center (Squaw Valley) Fall, 1979. There are twelve different stations in the circuit training program requiring a minimum amount of equipment. The circuit training program may be run using a set time limit at each station or by having the athletes perform a certain number of repetitions at each station. It is strongly recommended that athletes keep an accurate record of their own progress. This log can play a vital part in analyzing the strengths and weaknesses of each individual.

UPPER BODY EXERCISES

#1 Support Scull Action

Equipment - 2 free weights (5lbs and up)
Position - Standing or sitting
Action - Hold one weight in each hand, hands start in front of chest with palms up, scull out to straight arm position, bend arms to 90°, bring hands straight above head, reverse action. (Figure A)

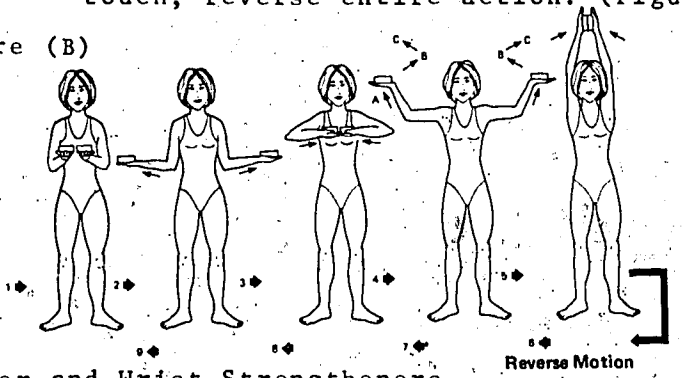
Figure (A)



#2 "Bubble Press" Scull

Equipment - 2 free weights (5lbs and up)
Position - Standing or sitting
Action - Hold flat weights with palms facing up in front of chest, scull out to side, "bubble press" (Figure B, steps 3 and 4) sculling up to straight arm position, rotate hands inward until fingertips touch, reverse entire action. (Figure B)

Figure (B)



#3 Finger and Wrist Strengtheners

Equipment - 2 free weights (5lbs and up)
Position - Sitting, elbows resting on upper legs.
Action - Hold weights in extended fingers, curl weights up with fingers to closed fist, complete action by curling weights with forearms, reverse action.

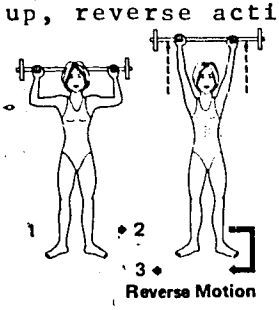
#4 Shoulder and Upper Back Strengthener (2 Variations)

Equipment - Straight bar with weight variations.

Position - Standing

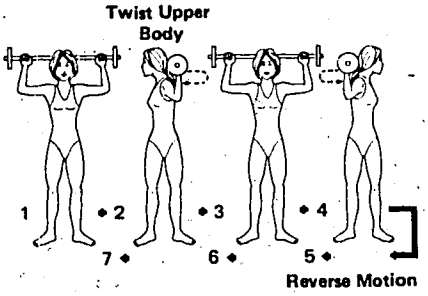
Action - (Figure C) Bar held in position behind head, extend arms and bar straight up, reverse action.

Figure (C)



Action - (Figure D) Bar held behind head, upper body twists from left to right.

Figure (D)



#5 Shoulder-Chest Press (2 Variations)

Equipment - Straight bar with weight variations.

Position - Lay on back, knees bent (on bench)

Action - (Figure E) Bar held across chest with arms bent, extend bar straight up, reverse action.

Action - (Figure F) Bar held with straight arms behind head, bring bar forward over head, reverse action. (Be careful to not use too much weight.)

Figure (E)

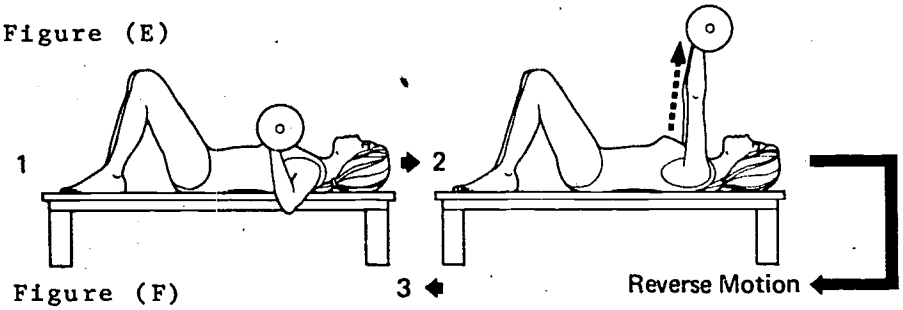
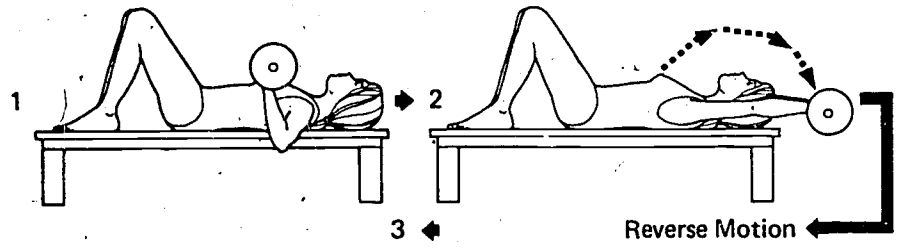


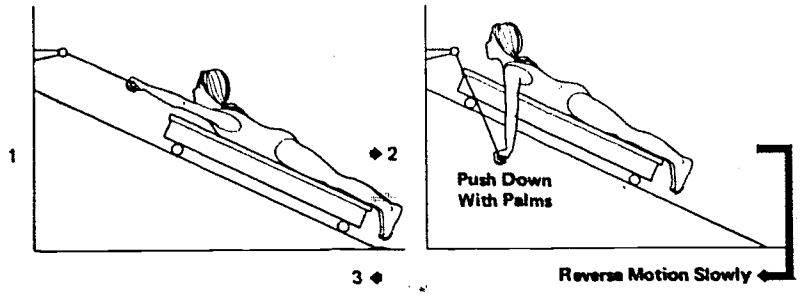
Figure (F)



#6 Free Swimming Strengthener (2 Variations)
Equipment - Exergenie, attach to a stable pole.
Position - Standing, with hands in stirrups
Action 1 - Face exergenie, pull through with freestyle action using right hand, left hand releases, pull through with left hand, right hand releases, repeat action - 2 sets of 30 repetitions.
Action 2 - Backside to exergenie, lay on bench with bent knees, repeat above action except using backstroke action.

#7 Butterfly Action.
Equipment - Rollerboard and exergenie
Position - Lay on stomach on sliding board, hands in stirrups with palms down
Action - Using both hands, press stirrups back towards hips pulling body up, control the reverse action. (Figure G)

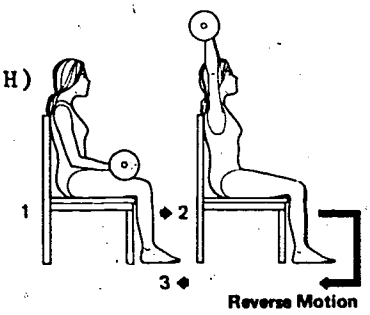
Figure (G)



#8 Arm Lifts

Equipment - 2 free weights (5lbs and up)
Position - Sitting, one weight in each hand
Action - Starting with weights on lap, lift straight up in front of chest and over head, reverse action. (Figure H)

Figure (H)



ABDOMINAL STRENGTHENER

Equipment - Slant board with weights (2½lbs and up)
Position - Lay on back with bent knees
Action - Place weight on chest with arms folded over weight, curl at hips to a 45° angle (partial sit up), curl down until middle of back touches board, repeat action - 2 sets 10 repetitions. (Use any sit up variation using weights.)

LEG EXERCISES

#1 Jump Rope
Equipment - Standard sized jump rope
Action - Start with a warm-up of 1-2 minutes of jumping, do speed jumping with only one jump between each swing of the rope 1 minute jumps with 20 seconds rest for 8-10 repetitions; use exercise at intervals during middle of season or endurance at start of season. (Try to jump on soft surface.)

#2 Ankle-Toe Lifts
Equipment - Bench, place so upper body is supported
Position - Stand on bench with heels off bench
Action - Let heels dip down, extend toes and raise up

#3 Toe Points
Equipment - Towel
Position - Sit with bare feet
Action - Place feet on towel, curl up towel using toes only

SYNCHRONIZED SWIMMING TRAINING TECHNIQUES

Mary Jo Ruggieri PhD

The concept of training girls and women athletes has taken on new dimensions in the past decade. No longer are we advocating that the training programs should not be as rigorous for females as they are for males. And that females are not capable of reaching the physical and mental peaks that we have pushed our males to reach. The challenge of training our female athletes is quickly becoming a science to many coaches. It isn't enough for women who currently are coaching to just have a complete grasp of the techniques of their sport, they must also have a thorough background on training theories to give their athletes the environment to reach their potentials.

Synchronized Swimming is quickly becoming one of the more sophisticated of the sports for women due to its recent gains in training theories. In the past several years, a great deal of physiological studies have taken place at the Olympic Training Camps and several universities. A Sports Medicine Committee has been set up by the National AAU Synchronized Swimming Committee which specifically deals in data collection and analysis to help promote better training techniques. The National Synchro Swimming Coaches Academy (NAGWS) has developed a research committee that is collecting data on training methods to be used to train high school and college synchronized swimmers.

The general areas of conditioning and training that are currently being covered in most competitive "synchro" programs are:

1. General competitive swimming conditioning
2. Specific synchro swim conditioning
3. Weight training
4. Flexibility and dry-land conditioning
5. Routine - Choreography training
6. Figure training
7. Nutrition and diet control
8. Sports psychology training

In the general competitive swimming conditioning most experts feel that the synchro swimmer's program should be similar to that of the middle distance

swimmer. Most routine events are between three to five minutes duration which physiologically places the emphasis on the aeorbic system. Several methods of conditioning the synchro swimmers have been successfully used. The following sample program has been used for several years at The Ohio State University:*

Pre-Season - A great deal of over-distance swimming is used to progressively over-load the swimmers. All four competitive swim strokes along with many synchro stroke variations are used during this phase of the training. A typical over-distance workout will include anywhere from two to four miles of swimming four to five days a week for four to six weeks. This over-distance workout can be handled several ways; the following is a sample workout:

1. Warm-up 800 easy free
2. Pulls - 400 individual medley
   Kick - 400 individual medley
   Swim - 400 individual medley
3. Sculling - 4 x 200 using different strokes
4. Kicking Drills 3 x 400 vary kicks
5. Synchro Drills
6. Swim Down 800 back alternate
   Swim Down 800 free in ballet legs every 200

The concept of over-distance swimming works well in the early part of the season to help athletes over-load systematically and slowly enough to prepare them for more resistance types of training later in the program.

Fartlek or Speedplay - In synchronized swimming fartlek type of training can be very successful during the first 25-30% of the season. The essence of this type of training utilizes varying the speeds of swimming to accelerate the heart rate on a gradual basis allowing for a pacino recovery period. Synchro coaches can adapt this system interspersing sculling techniques or ballet leg drills between the fartlek swims.

*Ed. note: other sample workouts are found in Synchro magazine.

Sample workout:

1. Warm up 400 individual medley
2. 800 free-pace first 100-increase speed second 100-time swim third 100 increases speed-return to pace last 100 and repeat 8 times.
3. 500-alternate 1 lap ballet leg-2 laps timed free-1 lap pace free
4. Synch drills
5. 30 minute fartlek swim continuous swim no break repeat the following:
   400 breast 50% sprint-1 and 3 laps
   100 hard free
   400 back 50% sprint-1 and 3 laps
   100 hard free
   400 fly 50% sprint-3 lap
   200 easy free
   continue to repeat series add head up freestyle and breast stroke for variations.

Any combinations of fartlek or speedplay drills can be used. A great deal of stroke technique and kicking drills can be done via this system.

Long Intervals - During the middle of the season a program of controlling the time and the distance the swimmers go and holding the heart recovery time to a certain rest interval is needed to generally get into aeorbic types of training. A minimum of 20-30 minutes of controlled long interval training 4-5 times a week seems advisable along with all the technique drills and routine swimming. A coach can accurately assess her swimmers progress by taking heart rates before, during and after the hard sessions of the interval swim. A general rule to follow when using this method is to try and work the heart rate up to between 160-180 and hold it there for at least 3 minutes, recover to around 140 and then increase again. After the set of long intervals have been completed a heart rate recovery after 1 minute should be taken. Most athletes as they become more conditioned will recover to 100 BPM or more after 1 minute.

Sample workout:

1. 400 free timed medium pace - rest 2 minutes
2. 8 x split 75's pace swim pull 1 lap, kick 1 lap, swim 1 lap, rotate strokes - rest 2 minutes.
3. 5 x 200 kicks time each 200 decrease each time rest interval 30 seconds - rest 2 minutes - check heart rates on 2 minute rests
4. 5 x 200 pull some - rest 2 minutes
5. 5 x 200 swim some - rest 2 minutes
6. 2 x 400 I.M. timed heart rates at end
7. Easy 200 breast

A lot of extremely short distance swimming and sprinting 50's and 100's is not advisable for synchronized swimmers because of the need for more aeorbic training.

Shorter Intervals - Just prior to peaking and tapering for Nationals a shorter interval program may be instituted.

Sample workout: Short repeats with 20 second rest intervals.

1. 4 x 100 free (timed 100)
2. 6 x 100 kicks (vary kicks)
3. 6 x 75 kick one lap, pull one lap, sprint one lap

Water conditioning is very important to the synchronized swimmer and must be consistent throughout the entire season. Often routines take priority over all conditioning and a balance should be maintained.

Included below is a general list of conditioning terminology that will be of benefit to the coach.

Types of Training: Fartlek, Over-distance, Interval, Repetition, Sprint.

Types of repeats used:

Straight sets - repeated swims - time and rest interval constant.
Decreasing distance - distance is decreased with each set.
Simulators - segmentation of distance with interspersed rests.
Mixed sets - distance and rest interval are not constant.
Progressives - each successive repeat is faster.
Regressives - each successive repeat is slower.
Alternating progressive - regressive - increase on odd numbered repeats, decrease on even numbered repeats.
Alternating slow - fast - hard alternate with easy repeat.
Broken set - small number of repeats with a short rest interval. Long rest and then another set.
Pulse rate rise and recovery used.

Types of dry-land:
Isotonics
Isometrics
Calisthenics
Weights

A general review of the total type of training program that could be adopted in synchronized swimming is included to give the reader an assessment of what can be developed.

GENERAL TRAINING PROGRAM FOR ANY SYNCHRONIZED SWIMMING TEAM

General Swimming

1. Over Distance (Pre-season) 3-5 weeks
   a. 1-2 miles of straight swimming with Synch things in between
   b. Nothing less than 500's
   c. No times - No speed

2. Fartlek Training 3-5 weeks
   a. Shorter distances but controlled speed at various lengths
   b. 400 I.M. sprint 1st and 3rd length of each 100
3. Long Intervals 5-7 weeks
   a. Time distance of swim and long rest between sets
   b. 3 x 200 free rest 25 sec.
4. Short Intervals last 3-4 weeks before Nationals
   a. Used for peaking
   b. Short rests - push swims
   c. No less than 100-200 yard swims

Keep track of all times so that times can be kept at a certain pace.

Dry Land Training

1. Aerobic Training
   a. (5-8 weeks) running steps (we have long steps in our Nat about 30-40 steps we run up, pace walk down) start 9 min. and work up to 12-15
   b. (3-5 weeks) jumping rope, 1 minute warm up, 3 x 3min sets
   c. (3-5 weeks) Harvard step test, step up and down on 18" bench 5-8 min.
   d. (3-5 weeks) run short steps (up regular school steps, must do them in certain times) 10 sets

We take heart rates after each time. We do these 3 times per week.

2. Weight Training
   a. Nautilus - October to April, 3 times per week 1 day in between
   b. Sit ups on slant board, 3 times
   c. Pulley's 2 times (isokinetic - use the bench pulleys only)
3. Yoga
   a. Do 10-15 minutes of the Yoga Warm-ups, 2 times
   b. See Yoga exercises

Synch Training

Besides regular skills and routines, do some of the following:

1. Power - drills
   a. 10 sets of vertical lobs
   b. 10 sets of cranes to vertical lifts with and without spins
   c. 10 sets of lifting movements
2. Movement progressions
   a. Inverted tucks to side splits
   b. Pike to crane
   c. Dolphin to vertical
3. Quick Originals - walkover to open action spin ups to splits to open
4. Kick Combinations
   a. side - breast - side
   b. free - fly - free
5. Coordination Drills
   a. Fly arms - free kick
   b. Free arms - breast kick (head up and down)

SAMPLE WORK OUT

1. Jump rope - 1 minute warm up, 3 x 3 min sets, heart rates after sets and again in 1 min recovery rate.
2. 1/2 mile - Krek pull series - fly, back, breast, free
3. Support sculls - power drills
4. Ballet leg series drills (footfirst) ½ singles, straight leg lifts, ½ doubles, doubles to flamingo
5. Support scull- power drills
6. Repeat ballet leg series
7. Kicking combos
8. Power drills
9. Routine work
10. 30 min. fartlek swim
    Ladder 1, 2, 3 lengths; pace 4, 5, 6; sprint 7 and 8 length slower. Keep repeating.

An example to a competitive swimming workout is given below to assist the coach in planning out a specific routine.

9 and 10 Age Group (L and O)

400	1.	1 x 400 fr. (sprint every other length)
1000	2.	5 x 200 IM - sprint 1st and 2nd lengths of each stroke
50	3.	1 x 50 warm down
1450		

11 and 12 Age Group (L and O)

400	1.	1 x 400 fr. (sprint every other length-circles)
1200	2.	3 x 400 IM circles - sprint every other length each stroke
500	3.	20 x 25 fr., 10 second rest
100	4.	1 x 100 fr. warm down
2200		

13 and Over Age Group (L and O)

500	1.	1 x 500 fr. (sprint every other length circles)
1200	2.	3 x 400 IM - circles, sprint every other length each stroke
1000	3.	20 x 25 fr. x 2; 10 second rest
100	4.	1 x 100 fr. warm down
2800		

Pressure II (Moderate)

500	1.	1 x 500 fr. (sprint every 4th lap circles)
2000	2.	5 x 400 IM (circles 1-3-5 reverse) 1. Sprint every other length (1st) 2. " " " " (2nd) 3. Sprint 1st 50 of each stroke 4. Sprint every other length (1st) 5. " " " " (2nd)
500	3.	20 x 25 fr.; 10 second rest (work hard, keep heart rate at 120 during rest)
100	4.	1 x 100 warm down
3100		

Pressure I (More Advanced)

1000	1.	1 x 1000 fr. (sprint every 4th lap - circles)
2000	2.	5 x 400 IM (circles 1-3-5 reverse) 1. Sprint every other length (1st) 2. " " " " (2nd) 3. Sprint 1st 50 of each stroke 4. Sprint every other length (1st) 5. " " " " (2nd)
500	3.	20 x 25 fr.; 10 second rest (work hard keep heart rate at 120 during rest)
100	4.	1 x 100 warm down
3600		

YOGA WARM-UPS

Eye Exercises - In a sitting position, focus your eyes on a specific point. Moving the eyes only, look up: (repeat each movement three times and close and rest the eyes after each movement). Look from the upper right corner to the lower left then from the upper left corner to the lower right slowly circle the eyes clockwise, then counter-clockwise. Finish by palming the eyes - rest palms of hands on closed eye lids for 30 seconds.

Neck Rolls - Exhale, drop chin forward. Slowly rotate your head clockwise three times, repeat rotating the head counter-clockwise three times.

Rock N' Rolls - Clasp hands behind knees and gently rock back and forth on rounded spine several times all the way back on the neck. In the beginning, do not roll too far back on the neck. Variation: clasp hands around knees.

Head to Toe Stretch - Inhale progressively while raising up on toes and stretching arms high overhead. Stretch and tense the body, hold breath; exhale, bending forward like a rag doll and let head and arms hang loosely. Return to position and repeat.

Chest Expander - Clasp hands behind the back, palms down. Inhale gradually as you stretch neck up until

the chin is pointing to the ceiling. Hold. . . exhale as you bring your hands up over your head and down toward the floor. Hold for the count of five. Inhale, return to original position. Repeat up to three times.

Star - Stand in a stride position. Inhale bend back; exhale bend forward touch right foot inhale up, bend back, exhale touch left foot, inhale up, exhale touch both feet; inhale bring arms above head, stand like a five pointed star, holding the breath and pose. Exhale, return arms to side, stand and observe the body.

Pre-Posterior Stretch - Stand in a stride position. Exhaling bend from hips keeping knees unbent and keeping the chin up. Touch fingertips to the floor and take them off four or five times. Back is kept stretched and head up. Still bent forward, inhale superficially and exhaling, relax back, shoulders, neck and head, swing arms and head back and forth between the spread legs four or five times.

Arm Turns - Extend arms at shoulder level. Bend elbow and circle lower arm three times in each direction. Circle wrists three times in each direction. Extend arms and circle the whole arm three times in each direction.

Trunk Turns - Stand with feet in a stride position. Place hands on waist and rotate the trunk slowly three times in each direction.

Ankle, Knee and Leg Turns - Stand on left foot, extend right leg, having knee bent. Circle the ankle three times in each direction: circle the lower leg three times in each direction: then straighten the leg and circle the entire leg three times in each direction. Repeat with left leg.

Feet Exercises - (a) stand with feet about six inches apart, hands on hips. Rise on toes: rotate feet to the outer sides, back on heels to inner sides and return to tiptoe position. Repeat ten times. (b) with feet together and hands on hips, practice

stationary walking, coming on the ball of the foot each time and arching the instep as you move.

Pump - Lie down and press small of back against floor so that all movements will proceed from center of back without straining stomach muscles. Slowly raise and lower one leg at a time - then both legs. Repeat three times for each leg and for both legs. Use count of eight or ten when raising and lowering legs to keep the mind focused.

Knee Press - Lie flat on back. Inhale, bend right leg, clasp it with your hands, pull knee to chest and bring your head to knee: hold five to ten seconds. Exhale slowly and drop leg back to floor. Repeat on other side. Repeat, pulling up both legs at once.

Cat Stretch - Kneel on hands and knees in "table position". Inhale, raise right leg and stretch it back as far as it will go; feeling the pull along the spine. Keep head up. While exhaling, bring leg forward and press knee against forehead. Repeat on the other side. Variation - In table position, flex the spine: head up as back sags, inhale: head down as back raises up exhale.

Shoulder Blade - In a seated position, arms straight out at shoulder level, inhale, exhale, draw shoulder blades together as though pressing a coin between them. Hold briefly and repeat entire movement several times.

Pre-Cobra and Pre-Shoulder Stand - Sit on heels; intertwine fingers at nape of neck, elbows as far back as possible. Inhale a deep breath and exhaling, let head fall to front, elbows coming close together as hands press against the back of the neck. Keep back straight. Inhale, lift head and straighten elbows. Repeat five times.

Hip Raise - Sit in diamond pose (on heels) or Japanese seated posture (curl toes under and sit on heels). Place hands on hips, keeping spine straight inhale raise trunk; exhale, lower trunk. Repeat ten times, action should be felt in front thigh muscles;

this exercise prepares the legs from the Camel and for the pelvic postures.

Raised Head and Leg Pose - Lie flat on your back. Lace fingers together and place them at the back of your head just above neck. Inhale, raise head, shoulders and legs off the floor. Hold briefly. Exhale, return to position and repeat. Gradually increase the number up to six.

AMBLYOPIA - with best correction, reduced visual acuity not correctable by refractive means and not attributable to obvious structural or pathological ocular conditions. Clinically exists if the vision of an eye is less than that of its fellow.

CONJUNCTIVA - a mucous membrane extending from the eyelid margin to the edge of the cornea.

CONJUNCTIVITIS - inflammation of the conjunctiva.

DEPTH PERCEPTION - perception of relative or absolute difference in distance of objects from the observer, perception of third dimension.

FUSION - the act or process of blending, uniting an image from the two eyes into one percept.

INCUBATION PERIOD - the development of an infectious disease from inception to visible manifestation.

MODIFIED CLINICAL TECHNIQUE (MCT) - an assembly line method of screening vision. It is a series of clinical measurements administered by a vision practitioner.

MONOCULAR - pertaining to or affecting one eye.

PHARYNGO-NASAL - pertaining to the areas between the cavity of the mouth, the esophagus and nasal areas.

SCLERAL - pertaining to the white, opaque, fibrous outer tunic of the eyeball covering it entirely excepting the segment covered by the cornea.

STRABISMIC - pertaining to the condition in which binocular fixation is not present under normal conditions.

VISUAL ACUITY - acuteness or clearness of vision which is dependent upon the sharpness of the retinal focus, the sensitivity of the nervous elements, and the interpretative faculty of the brain.

ANALYSIS OF VISION NEEDS IN SYNCHRONIZED SWIMMERS

Susan G. Louie, OD

Sixty-two female synchronized swimmers, ranging in age between thirteen and twenty-one, were tested at the United States Olympic Training Camp in Squaw Valley, California. The median age was sixteen. For swimmers neither specialized glasses nor contact lenses to this date have been satisfactory in resolving specific problems associated with competitive water sports. Visual needs for swimmers are essentially the same for most sports. Water is the only limiting factor. Peripheral vision and visual acuity are important to all swimmers. However, depth perception capabilites are an even more important quality for synchronized swimmers who swim in relation to other swimmers of the team. Patterns of a routine are maintained as swimmers are equidistant to each other and the edge of the pool. Aspects of judging are based on execution of the routine through synchronization and projection of individual swimmers as part of the content of the routine. Confidence during training and competition are dependent upon many factors, the visual status of the swimmer being the most unexplored.

Each swimmer was given an eye examination patterned after the Modified Clinical Technique, an established vision screening procedure developed through studies in Orinda, California approximately seventeen years ago. Included in the testing were the following:

1. Visual acuity of each eye at distance with and without corrective lenses.
2. Binocular coordination measurement for the ability of the muscles of the eyes to work together. A general evaluation of fusional abilities and therefore broad depth perception capabilities.
3. An objective measurement of the degree of nearsightedness, farsightedness, and/or astigmatism each eye.
4. Gross procedure for the extent of peripheral vision each eye.
5. Inspection for abnormalities regarding the

general health of each eye.

Most testing was performed without correction to simulate actual training and competition circumstances. The second aspect of the study was observation at the poolside on individual swimmers who expressed or demonstrated visual problems. The third part was extensive questioning of swimmers who failed the MCT without corrective lenses. Questions concerned:

1. Awareness of vision difficulties while training, while competing.
2. Depth perception problems; specifically touching the edge of the pool before visual sight of the edge, swimming into other swimmers frequently when the swimmer thought there was adequate space between the other swimmer, alignment problems.
3. Peripheral field problems, specifically the inability to see or be aware of other swimmers to the side.

The fourth procedure for this study entailed conversations with the coaches of the various teams participating. Specific individual swimmers were analyzed from the coaches point of view as to visual problems they noted.

The results of the study revealed the following:

1. Out of the sixty-two swimmers tested, thirteen wore glasses only, four wore hard contact lenses and/or glasses, one had soft lenses only, and two had hard contact lenses only. Consequently, twenty out of the sixty two (32%) required corrective lenses.
2. Another seven with no previous or present corrective lenses expressed problems with their vision. They were referred to their coaches for extensive visual follow-up. This brought the total to 45% out of the sixty two swimmers who required visual attention.
3. Of the twenty with corrective lenses, eight (40%) expressed problems with depth percep-

tion and/or poor vision while training. Of the seven contact lens wearers, four with hard contact lenses attempted to wear their hard lenses with swimming goggles during training. Only one was successful.

4. Peripheral fields tested without corrective lenses in all swimmers was within normal.
5. Depth perception problems appeared to be the most common.
   a. Of those expressing depth perception inadequacies and visual acuities of 20/50 or worse each eye, three had binocular coordination difficulties, failing the test at an intermediate distance, the more appropriate distance for synchronized swimmers. Of these three, only one had significantly reduced vision without lenses.
   b. Of the swimmers who expressed no depth perception problems only one was a borderline pass/fail according to binocular coordination criteria. Visual acuities were only slightly reduced.
   c. Of the swimmers who had no corrective lenses, two failed the binocular coordination criterias. Both, however, had visual acuities of normal range and no complaints of depth perception problems.

A number of correlations can be obtained from these results.

1. The amount of nearsightedness and binocular incoordination can attribute to the lack of depth perception expressed by some of the athletes.
2. For those swimmers who wore their corrective lenses all or more than fifty percent of the time outside of their swimming, there was more difficulty in adjusting to the lack of acute vision normally accomplished with corrective lenses. Therefore depth perception was a moderate to severe concern.
3. Compensation to the visual lack of depth perception was achieved through various

adapting, i.e. "looking for objects around to help." The most common method was repeated practice of a routine with the aid of the coach's comments to indicate to the swimmer when she was not in alignment with other swimmers. One swimmer had been corrected by her coach so often, she now automatically stayed behind the line-up even though visually she did not see herself in line. Repeated instructions from her coach indicated she must be in line. The other method of compensating was through the use of parallax movement, that is moving the head side to side using the object or objects of alignment as reference points. This is a common method for those with reduced depth perception, who tend to use familiar objects, such as fire hydrants or lamp posts while parallel parking an automobile.

3. Those swimmers who utilized corrective lenses less than fifty percent of the time outside pool activities adapted easier and faster without corrective lenses or were unaware of the concept. Two of the swimmers who were amblyopes, using only one visually good eye since birth and one swimmer who was strabismic, utilizing only one eye at a time since birth, had no complaints of depth perception problems, nor did their coaches indicate any alignment difficulties. This further enhances the possibility of some form of depth perception as opposed to true depth perception derived from equal input through the two eyes to the brain can be a learned process.

Recommendations based on the preceding results and correlations indicate several alternatives for those swimmers with moderate nearsightedness and/or depth perception complaints.

1. For those moderately nearsighted swimmers starting young, up to approximately age twelve to fourteen, there is an advantage

to the coach if no corrective lenses are utilized while training in the pool. Once an individual becomes sensitive to the improvement in vision with corrective lenses and prefers to wear their lenses most of the time outside of the pool area, it will be more difficult to train them without their lenses. This difficulty is related to both confidence and skill.

2. Swimmers with moderate to high nearsightedness consistently lacked confidence when entering the pool without corrective lenses. "I know my eyes are not as good as the other swimmers, and I'm at a disadvantage." Coaches need to be aware of this confidence level as it relates to vision problems. Most felt they "could do it, if they had to," but they were more comfortable if given the opportunity to see clearly. It appeared more important to the swimmers to see clearly during training, not during competition. Coach Don Van Rossen formerly from University of Oregon referring to speed swimmers was quoted[6]. "I've seen a lot of injuries (such as split heels) because of a slight miscalculation. We find that when our guys are using the masks (prescriptioned goggles) they attack the turn more aggressively because they can see better and their confidence is increased."
3. For those swimmers with high amounts of nearsightedness, hard contact lenses worn with goggles appears to be a viable alternative provided the fit of the lenses are accurate and the swimmer is comfortable with this arrangement. Soft contact lenses are assumed inappropriate even with goggles since soft lense materials will absorb the chlorine which will turn the lenses a yellow color. There is inevitable seepage of water even with goggles. Hard scleral contact lenses are very comfortable because they must cover the whole eye to avoid "popping out." They are also very expensive and vision is not as good. Hard contact lenses as an alternative is not without limitations. The high unsuccess rate

can be attributed to the following complications.

a. Redness of the eyes due to the combination of hard contact lenses and chlorine.
b. Displaced lenses as the swimmer rotates her eyes during projections and underwater movement of the eyes with goggles on.
c. Lenses popping out due to the exaggerated and constant opening and closing of the lids during the removal of goggles as the swimmers come in and out of the water. Most swimmers prefer to remove goggles while their head is above water for better vision. Blinking is severe because it also serves to wash away the unnecessary water and chlorine.
d. Due to the irritation of the eyes from the chlorine and the nature of the hard contact lens, there is a foreign body sensation which is more severe than usual.
e. The fear by the swimmer of losing her contact lens in the pool which has happened to most of the swimmers who attempted this alternative. Reports of "never" losing a contact lens in the water[6] must be viewed with extreme caution. There is a strong insecurity and therefore a lack of confidence in their swimming ability if they are pre-occupied with losing their lenses.

4. Because goggles are not allowed during actual competition, it is highly recommended the swimmer wear the hard contact lenses with goggles only for the training session and allow at least one to two weeks for training without the lenses prior to competition. All swimmers questioned felt it was a dramatic transistion to swim their routines without accurate vision if trained with corrective lenses.
5. When instructing swimmers during the training sessions, many of the coaches unaware of the vision of some of their athletes would indicate for them to focus on an area within the

pool setting when emphasizing "projections" or aligning of the swimmers for the synchronized routine. This study indicates as high as 45% of the swimmers may need visual attention and therefore may not be able to easily "focus" or "align." An alternative to this method of instructing is specific directions, e.g., "turn your head 45° from the straight ahead position," versus "turn your head to face the clock on the wall," This also aids to avoid "squinting" or squeezing of the lids by most nearsighted individuals as they attempt to see the clock. Projecting without focusing will help to eliminate facial distortion, a disadvantage in competitive synchronized swimming.

6. One of the most common complaints of coaches and athletes was glare from inside the pool lights above and beneath the water and outdoor sun. Goggles appear to help but do not completely eliminate the discomfort. Goggles need to be tinted darker to ease the circumstances during training; however, since goggles are not allowed during competition for this specific swimming event, this problem may be an unresolvable one.

7. Conjunctivitis[1] is a frequent ocular problem, often associated with ear infections. Easily transmittable through water with an incubation period of approximately five to seven days, symptoms may vary with associated pharyngonasal problems. Duration may be from one to two weeks; the conjunctivitis may be monocular without secretions. Dr. Jastremski reported on the importance of the acid-base balance of the water in preventing eye inflammation.[2] He notes "for every ten degrees temperature rise the reactivity of the acid or basicity of the water on the conjunctiva doubles, therefore cooler water causes less eye irritation." His recommendation for preventive and therapeutic care is rinsing the eyes thoroughly after a morning practice session with normal saline obtainable at a pharmacy. This may eliminate recurrence of the irrita-

tion with the afternoon session. He also recommends washing the eyes often with plain water. Some coaches and swimmers prefer artificial tears to soothe the eyes or ocular decongestants to eliminate redness, however, these will not alleviate the conjunctivitis. Some coaches remove the swimmer temporarily from the pool to prevent more irritation and/or the possibility of conjunctivitis spreading to the other team members.

All synchronized swimmers with vision problems need to be evaluated routinely. Due to the specific nature of their sport, depth perception, as well as keenness of vision and peripheral vision play important roles in the confidence and level of competence. Normally the basic premise is to maximize visual acuity in each eye to enhance binocular coordination, and thereby improve depth perception. Maximizing visual acuity in competitive synchronized swimming is limited. Therefore a general awareness of vision by the coaches and an open communication between athletes and coaches would reveal any insights which may lead to the improvement of the skill of the swimmer in either learning or performing her routines at a competitive level. Some of the swimmers expressed an "awkwardness" in discussing vision difficulties with their coaches because they "didn't think it was important enough." The confidence of athletes with decreased vision should be a concern for coaches who can then become more atuned to the needs of their swimmers.

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THE USE OF GROUPS TO IMPROVE ATHLETIC PERFORMANCE

David T. Nesvig, EdD

INTRODUCTION

As part of the Athlete Development Workshop program for A.A.U. synchronized swimming teams sponsored by its Sports Medicine Committee, groups were introduced to discuss coach-athlete and athlete-athlete relationships. It was one component of a psychologically-based regimen designed to assist athletes in coping with the results of stress in high level competition. Other modules include application of biofeedback, use of relaxation techniques and autogenic procedures to improve performance levels.*

Conducted in 1977, 1978, and 1979, these groups have been utilized with the top 25 United States A.A.U. synchronized swimming teams during week-long workshops conducted at the Olympic Training Center, Squaw Valley, California, as well as with a speed swimming team in a large metropolitan area.

Each group consisted of the coach, and in some cases, an assistant and his or her swimmers meeting with the facilitator, (the author) to discuss concerns about competition, practice, performance, team goals, and mutual expectations. Usually there were 8-10 swimmers in each group plus the coach.

PURPOSE

Four primary goals and one secondary goal were determined for the groups as sub-goals of the more global one of improving performance levels for all participants:

1. To explore the working relationship between coaches and athletes and athletes to one another in terms of improving the collaboration in both directions.

   In terms of the group experience, the process could range from simple self-disclosure to develop a higher level of trust, to contracting for actual behavioral changes or other

*Ed. note: see Wenz & Strong pp. 153-179

concrete agreements regarding practice routines.

2. To effect a better understanding for coaches and swimmers of the similarities and differences of their goals and behavioral operations in relation to role distinction and clarification.

   In the group this would necessitate discussion of commitment to the sport, rewards and payoffs, the decision-making process, how conflicts are resolved, etc.

3. To bring hidden feelings, misunderstandings and personal agendas into the open.

   As the group discussion progresses these issues normally unfold as mutual collaboration is encouraged by the group facilitator.

4. To integrate learnings from the other psychological components of the workshop program (relaxation, autogenic techniques, biofeedback procedures) in relation to improved performance levels.

   Particularly when the focus is on collaboration of swimmers with one another and coaches, an attempt is made to bridge the application and utilization of techniques learned in other components. The emphasis is once again on improving practices and competitive performances through lowering stress levels.

5. To provide data for improving the psychological components of the program is a secondary goal of the groups.

   This data is collected informally by observation of the facilitator and through direct and indirect feedback of group participants. Since a formal written evaluation is done at the end of the workshop, no attempt is made formally to structure this in the group.

For the purpose of this article, the discussion will center on the first four goals, which are primary. A significant section will be devoted to swimmers' motivation and their reasons for making a long-term commitment to the sport. This will be based on actual responses by the athletes to questions concerning their level of commitment, the pay-offs and rewards for them as swimmers.

GROUP STRUCTURE AND PROCESS

During the late 60's and early 70's when the encounter group movement flourished, the typical social entree was not "What astrological sign are you?" but more relevantly then "What group are you in now?" Psychologically and growth oriented groups were given a great deal of bad press, much of it deserved.

Anyone who lived through that era is likely to have a wide range of reactions and images when presented with the generic term, "group." Unfortunately many of the images may be negative, may trigger off memories of less than positive experiences with a group led by an unprofessional, poorly trained or unethical group facilitator. The term may elicit associations like: therapy group, encounter group, confrontation group, rap group, support group, experimental group, wide-open group, counseling group, "touchy-feelie," or sensitivity training. On the other hand, the word may have a positive valence, connoting pleasant memories of a fruitful group experience resulting in growth or change. These reactions, whether negative or pleasant, can result in a perception about groups which has the potential to significantly alter any future group experience. Our expectations are powerful determinants in influencing subsequent exposure to a perceived similar experience. Because of this, I made a deliberate attempt to demystify the perceptions about groups in advance at a general meeting of coaches. A brief introduction was given at the initial orientation meeting for athletes as well. Heavy emphasis was given to the central purpose of the group - an opportunity to discuss common concerns, goals, worries and experiences related to high-level competition. Here was a chance also for the team to

meet under more relaxed conditions without the usual time pressures of a tight weekly training schedule.

Following this description, they were told what the groups are not. They are not counseling, therapy or encounter groups. All participants were reassured that embarassing personal questions would not be asked, their family history would not be probed and that all questions would be answered as directly and honestly as possible. Informal follow-up at meals and during breaks gave me the opportunity to answer further questions of the coaches and athletes. These contacts resulted in stronger rapport and served to lower any further resistance to group participation.

At the beginning of each group discussion, the purpose and goals of the group were once again repeated, the structure explained, and the demystification process gone through. Feedback from coaches and swimmers indicated that this was not redundant or overemphasized, rather it was seen as valuable and, in some cases, essential to the group's direction and success. The next step in beginning the group was for me to make a personal statement which led into the first phase of discussion. Following is an approximation of it:

> I've been a sports nut most of my life, as a competitive tennis player, sports writer and fan and I have to tell you how impressed I am with the level of commitment I've observed in you synchro swimmers and coaches. I don't know of a sport with any higher level of commitment from its athletes, practicing five-six days a week, seven before meets, 11 months out of the year. I've heard also that it means often two practices a day, many times standing around shivering by the pool or rehearsing in chilly water. So, I'm really curious to hear from you, what is it about this sport that makes you willing to go through this?

The responses were informative and enlightening to me and often were revealing to the swimmers and

coaches. Many themes developed which were common to every group, while others were idiosyncratic. In analyzing the answers given to this global question, 27 themes developed. Due to the overlap it might be more accurate to say there were consistently a dozen themes which seemed to arise in each group. Some of the most often mentioned reasons included:

It's an opportunity to travel around the state, the U.S. and to other countries.

I've made a lot of new friends, many very close and important to me.

It feels good to excel in something.

I've developed self-esteem and confidence I didn't have before joining the team.

It's fun performing for an audience.

It keeps me in shape and slim.

I enjoy the challenge of competition.

After this opening discussion other pre-determined questions were introduced by the leader to direct the flow of discussion. The questions were developed to provide a clear focus for the group and avoid meaningless meandering. In my experience many of the issues the questions were formulated to elicit, for example, contracting and conflict resolution, arose naturally from group members, requiring no prompting.

If the discussion on level of commitment was slow in beginning, related questions were introduced, such as, "What are the rewards and payoffs for you in synchro swimming?" and "Why are you willing to sacrifice precious time you could spend studying or on other pleasures?"

DEVELOPING GROUND RULES FOR ASSISTING ONE ANOTHER

Depending on the issues raised spontaneously in discussion, this topic would be approached next. The stimulus question would be similar to this,

> How do you help out one another in practice or before a meet? How about in practice or before a meet? How about during and after competition? What have you found helpful to you and in assisting a team mate?

What is universally generated in discussion of this topic is an awareness of strong individual preferences for giving and receiving feedback on performance. It was my observation that this was concrete and specific enough as well as universal to all participants' experience, that many areas were tapped. In fact, if there were no time constraints, this subject could be explored for the full two hours. Specific examples of ground rules will be given later. More attention will also be given to what swimmers say coaches do or say that is helpful to them.

CONTRACTING BETWEEN COACHES AND ATHLETES AND ATHLETE-TO-ATHLETE

Contracting was a topic that did not normally arise directly, but often indirectly during group interaction. Since it is a term not usually used in verbal interactions, it was introduced when participants were talking about how discussions are made. Once the subject was broached, the leader would follow up with,

> How are those decisions made? What chance are you given to provide input? Is your voice considered or heard when decisions are made that affect you?

These and similar leading questions are used by the facilitator to lead into an exploration of contracting. Principles of contracting and anecdotes illustrating them will be offered later.

CONFLICT RESOLUTION

This can be potentially the most explosive subject of all those mentioned. Likewise it can result in healing wounds which have severely obstructed communication for an entire team.

Many times current unresolved conflicts are alluded to indirectly or are raised directly by coach or athlete in another context, such as decision-making. Other times past misunderstandings which still are simmering are brought into the open. Again, if the subject is not brought up, the leader will refer to some other reference with a statement like,

> When you referred to your difference with (name) I wondered how you handle disagreements and conflicts on the team?

As the facilitator response indicates, the attempt is to depersonalize the conflict, that is, treat it as a normal, inevitable occurrence on any team. The message is that it is a predictable event and there are effective ways to handle disagreements. If it is clear that an unresolved conflict exists that is having a present negative effect on the team or individual, it may be briefly used as an example of a conflict and how it might be dealt with. In at least three instances, it was my judgment that more time was necessary than was available to sufficiently explore the issue. In those cases a second session was arranged for another time during the workshop.

Each of the preceeding sections which have been introduced will be given more detailed attention at another point in this article along with examples and anecdotes.

SWIMMERS' AND COACHES' MOTIVATION

Previously, an introduction was made to this topic detailing swimmers responses. Not included in that section were coaches answers to the question of their willingness to make such a significant contribution of their energy, time and resources to the

sport. On the one hand their reasons were frequently similar to the swimmers, like the opportunity for travel, making friends, and the sense of excelling in an activity. On the other hand, their role as coach clearly dictates other sources of payoff and rewards for them.

As one might expect there was seldom one compelling reason expressed as the major determinent apparent in staying with the sport. Responses unique to coaches were:

> The chance to work with good athletes who are also nice kids. In my experience these girls are the 'cream of the crop.'
>
> I enjoy the teaching aspect of coaching.
>
> It's an opportunity to develop my teaching ability.
>
> Developing a team from a group of basically raw, inexperienced swimmers is a personal challenge.
>
> To continue the tradition of excellence and winning that the (team name) have established.
>
> I can see instant results from my coaching and teaching.

Coaches in particular seemed to welcome the permission given by the group structure to be more personal in revealing the complex motivators which keep them involved despite very low pay and demanding schedules which complicate their lives. Almost without exception, the team members were hearing some of these reasons declared for the first time by the coach herself or himself. The impact was sometimes startling, not only on the athletes but on the coaches as well.

For the coach, answering the question sometimes led to clarification of priorities "You know, I realize now that I probably would have quit before

now if it weren't for my compelling desire to see synchro swimming become an Olympic sport." For the swimmer, listening to her coach reveal highly personal revelations led to seeing her coach as a real person, not in a narrowly defined role of the coach. "Wow!" one girl exclaimed after her coach opened up, "I didn't know that before about you. I'm glad to know that." Here was the beginning of the breakdown of the stereotypes of coach as disciplinarian, administrator, slave driver, teacher.

Some coaches engaged in a deep level of personal disclosure as they talked. They talked poignantly of coaching filling a void in their lives left by retirement, relocation, or the death of a loved one. They spoke of coaching as a release or outlet for frustration in their professional careers apart from coaching as a source of recognition. Others spoke of the importance to them of the swimmers as their "children."

As the coaches displayed varying levels of self-disclosure and risk-taking, the seeds of collaboration were sown. This modeling by the coaches encouraged the athletes to do the same. It also was the beginning of a new perception of the coach which made him or her more approachable, less formidable or distant. Other personal agendas were now more likely to be brought into the open. A major goal of the groups was now being addressed.

Coaches are certainly not immune to personal ambition. One coach mused about her desire to crack the top five nationally and make her team eligible for a seeded position and international competition. At the same time, as she talked about her affection for the girls, she displayed her caring nature in a direct way never made clear or experienced by athletes in practice. Again, the group process became a vehicle for a previously unattained level of mutual understanding.

Other coaches shared the complex demands on a coach. Swimmers heard about their coach as a diplomat and politician who must deal with angry or pushy parents and boards. They heard about the demands of

fund raising and endless details of planning and coordinating meets thrust upon the coach and assistants. They learned of coaches own ego needs, that, to coin a pun, "Coaches need strokes too."

This knowledge was beneficial in relation to the discipline of practice; knowing in more detail the demands placed on the coach made it easier for athletes to accept demands placed upon them by the coach. They now knew on a more conscious, practical level that they were not being singled out for extra work.

Returning to the reward system operating for swimmers, coaches listening to their proteges discuss reasons for commitment similarly resulted in the coaches acquiring a deeper level of understanding and a more tolerant approach to their athletes' needs as non-swimmers. The factors which contributed to a swimmer's desire to stay involved ranged from such personal ones as family expectations ("We're all swimmers in our family.") to prosaic almost negative factors ("It beats watching TV and being bored.")

Of special interest o me was what girls had to say who had been competitors in other sports at school including speed swimming, gymnastics, diving. For several of them, the attraction of synchro-swimming was an integration of the elements of ballet, gymnastics, swimming, diving in one unique, esthetically pleasing activity.

Without attempting to organize them by category, other statements or motives for competing ran the gamut of personal recognition, group support, achievement needs, peer recognition, team loyalty and the development of personal effectiveness. Further specific examples are:

> I need the discipline of daily workouts and routines.
>
> Being on the team is like being in a family. As a matter of fact, I spend more time with them than with my own family.

I want to make the "A" team.

I want to stay on the "A" team.

I like the appeal of the form and beauty of synchro. Swimming to beautiful music inspires my creativity.

Performing in front of the public is really neat, having my friends and family see me.

I want to see our team make the top ten.

What's really important to me in staying with the team another year is beating (team name).

Synchro is a special sport that a lot of girls in other sports could never be a part of - you have to be able to swim, dive, be a gymnast.

I get to travel all over. Most girls my age haven't traveled like I have.

I don't have to go home to my bad family situation after school.

It's really neat to be a (team name) and hear other kids and swimmers say, Gee, are you a _____.

I've learned a lot about getting along with people.

I feel much more confident than I ever did before I was a competitor. It's really helped me at school getting along with others.

I used to be really shy and down on myself, but not anymore. It's easier for me to make friends away from the pool, too.

I understand myself much better than before I became a _____. Being under the pressure of competition, having to organize my time better, working closely with others, developing a sense of loyalty, learning discipline have been incredibly valuable to me.

This last statement was not an isolated statement, but rather one that emerged in similar words from several members of each team. So much has been written and said about personal development in athletics that it has become a cliche that we have come to mistrust. Without any behavioral follow up as documentation, it can be said that at least the self report of these athletes is a strong indicator of a carry over effect from participation in a sport to life situations. Their reports indicate that learning which occurs as a result of the rigors of practice and competition generalizes to their daily life problems. Personal and interpersonal effectiveness is enhanced as well as self-esteem, in many cases. Given the limitations of self report and all of the biases inherent in this method, nevertheless, for this group of athletes, there is a trend which supports the view that sports activity can be positively correlated with behavioral changes which effect non-sports segments of their lives. In turn, these data are linked to continuation in the sport by the swimmers.

Developing Ground Rules for Assistance

Following the discussion of commitment and motivation the subject of how athletes helped one another was introduced; this included daily practice, competition and post-competition situations. Conversation centered around giving feedback in a helpful way as well as on the receiving of feedback from fellow swimmers and coaches. This subject area, in my observation, seems to set the stage for the next area of contracting. There appears to be a flow to asking for feedback to be given in a different manner or at a particular time.

In the introduction, examples of stimulus questions were mentioned. Once the group begins talking about techniques and methods they find helpful, the leader utilizes this to generate ground rules for giving assistance.

A universal ground rule was: Be specific in describing what you observed, either positive or negative. (Here a note should be made that while these principles my be well understood and effectively applied by the coaches and many swimmers, they are not equally so for all team members, and therefore worthy of repetition.) It is not much help, as many persons noted, to say something vague like: "You didn't seem to have much crispness in your turns. You seemed kind of lazy and lackadaisical that time." The words "lazy," "lackadaisical" and "crispness" are subjective and may have a specific meaning to the observer, but to the swimmer being corrected, they may be too vague to be of assistance.

A more concrete specific rephasing of the example might substitute "It would be better if you would turn more quickly by pushing off with more thrust from the edge of the pool." This example likewise illustrates a second principle: Be constructive in offering criticism.

Members of the groups consistently were critical of statements prefaced with zingers like: "Well you really blew that one!" or "You certainly have a lousy attitude today." They were all more receptive to opening comments like: "You might try..." or "It might be better if ..." or "How about next time ..." These beginnings make the listener much more open to the concrete correction which follows.

Another ground rule growing out of the first two is: If possible, demonstrate the change desired. Many movements in synchro-swimming are extremely complex and difficult to describe, even for the most articulate observer. Because of individual learning patterns, modeling the correct technique may be essential. One person may be able to translate the word to the concrete physical movement designated,

while another may need a demonstration to make it clear.

The next ground rule related to a frequent complaint voiced by swimmers toward their own peers, as well as coaches. This complaint concerned lack of positive reinforcement or praise. Swimmers groused that "you always tell me when I screw up but you never say anything when I've done well." The ground rule became: Give verbal praise when earned or deserved. The qualifiers earned or deserved were added because the athletes wished it to be sincere, not used in a phoney way to give false encouragement.

These ground rules have dealt with giving feedback but do not directly address the reciprocal nature of feedback. The same principles apply to the receiver of the feedback in acknowledging or hearing the correction or praise. If the feedback is not understood, then the listener needs to be specific and constructive in requesting clarification. Conversely, if the feedback has been useful, it assists the person to know that it was. This knowledge makes it easier for the person to know if his or her feedback is on target. If the observer hears, "That really helped me to improve that drive. I've been having trouble with that for weeks, and I couldn't get the entry just the way I wanted it," it also makes it more likely the feedback given will risk such an observation in the future.

This latter point was reinforced through a quick exercise introduced by the leader. Each person was asked to think of a person who, in his or her estimation, gives clear, direct, useful feedback, in short, someone who applies the principles just developed. A reporting out of these, with examples, served as illustrations. It also provided an effective summary of the ground rules for giving assistance.

Contracting

The summary also led naturally into an exploration of contracting. Although seldom referred to as contracting, the notion was frequently raised in the

context of decision-making. The principles of giving and receiving feedback were then broadened to encompass team issues such as practice times, planning routines, determining A and B team members, solo and duet partners, and the selection of travel squads.

Principles of contracting are an extension of those laid down on giving assistance and feedback. An interesting array of issues was typically raised for potential contracts from such seemingly picky items as how soon before a competitive meet costumes should be worn, to more fundamental matters of how music for a routine will be chosen. Before getting into making actual verbal contracts, group members were reminded that the goal of contracts is to improve team and individual performances. An extension of the feedback guidelines applied to contracts would specify the contingencies each person consider:

> concrete, observable behavior (actions or words),
> the specific behavior to be changed,
> state constructively and positively the conditions,
> if possible or appropriate, indicate the time element involved.

One of the first contracts worked out in the group dealt with what to a non-swimmer might seem an inconsequential problem; yet to the swimmer competing on a highly ranked team, was cause for consistent pre-competition tension on the team. The tension often resulted in the flaring of tempers and distraction which, for some, led to a lower level of performance than the offended individual might attain under calmer conditions.

The source of irritation was a habit one team member had of not getting her hat and pins in place until a few moments before the team formally began competition. For the rest of the team, the norm was to have this taken care of 15 or 30 minutes beforehand. Nagging by other teammates or coaches resulted only in more attention being paid to this annoying habit and less to essential last-minute preparations. A standoff had resulted which was the source of much unproductive gossip, name-calling, and accusations.

After both the identified norm breaker and the team discussed the reasons for their positions, a contract was decided upon, basically a compromise which satisfied both sides in the issue. The contract specified:

1. The recalcitrant swimmer agreed to have her hat and pins in place no later than 10 minutes before a meet.
2. Team members agreed in turn to make no mention of the costuming until the 10 minute deadline.
3. If the deadline was not observed, other team members would be allowed to point out her unreadiness until she complied.
4. If the deadline was met, team members would thank her for her compliance.

This example illustrates the principles. It deals with concrete, observable behavior (placing hat and pins on head), specifies the behavior to be changed (observe the 10 minute deadline), indicates what must be done in a positive statement (have hat and pins on head), rather than what must not be done, and finally, makes the time element clear (10 minutes before each competitive meet, not practice).

A more complex analysis of contracting, including other principles, conditions, and follow up, did not seem appropriate for the group. Given the shortness of time and other priorities for attention it was kept at this level.

Due to the uniformly positive evaluation of the groups, almost every team agreed to continue with follow-up meetings after leaving camp. The only exceptions were those few teams of the 25 that already had regularly scheduled team meetings. Final negotiations took the form of a contract which included time, location, who shall attend (e.g., coaches, A team, B team, volunteer assistants), frequency and length of meetings, agenda, and designated leader. This settlement was similarly used as an illustration of contracting.

Conflict Resolution

It is inevitable on any athletic team during the course of a season that varying degrees of conflict will arise among its team members, coaches, board members and volunteers. Based upon this premise, the topic of conflict resolution is undertaken in the group. From the stance, that conflict is normal and unavoidable, it is hoped that a dispassionate view of conflict resolution can be reached.

If a conflict, either current or past, is not raised by a group member, the facilitator will simply initiate the subject through questions, reminders or other allusion to conflict or potential areas of conflict. Occasionally a present or impending conflict on a team was immediately focused upon as in the previous illustration of contracting (placing hats and pins on before the meet).

Before zeroing in on particular conflicts, a more wide-open conversation was encouraged on the negative effects of unresolved conflicts. It was my observation that every team was aware of the consequence in terms of morale and performance. What they were unaware of was how to begin to resolve the conflict. In those instances, assistance was provided in identifying and breaking down the sources of conflict.

Once the sources of irritation were identified they could then be approached. If the irritant was a particularly offensive rule or policy, the coach or a senior member of the team was asked to provide an understanding of the rationale behind it. Frequently information alone was sufficient to either resolve the individual's conflict or reduce it to the point of making it livable or acceptable. If the conflict was interpersonal, however, it often required more time than could be justified to devote to it in the initial group. If so, a follow-up session was scheduled to continue the attempt at resolution. This was amicably accepted in three instances and a private meeting was arranged for the group.

No reason was seen as too trivial for

consideration as long as it had consequences for any member of the team. Rules and policies concerning practice, travel, dress codes, room assignments on the road, free-time dating, curfew, eating restrictions, horseplay, access to the pool, and post-competition parties all were problem areas for some.

The Coach - Whoever That Is

Ask 20 athletes and you're likely to get 20 different responses to the queries "What do you want most from a coach?" or "What do you find most helpful in a coach?" After meeting with 25 teams, I have found that at least synchronized swimmers are expecting a new breed of coach. Their expectations are complex and not easy to categorize. Consistent with a more traditional view of the coach's role, they want an organizer, a motivator, a disciplinarian, a teacher. Swimmers in the '70s and '80s, while still valuing those multiple roles, expect -and sometimes demand- more. They are also looking for a technician, a trainer, a collaborator, a problem-solver and, perhaps, a personal mentor.

STRESS, COMPETITION AND PSYCHOLOGICAL FINE-TUNING

Betty J. Wenz, PhD
Donald J. Strong, PhD

Athletes of all ages and levels of skill suffer the pangs of competition anxiety at times. Mental preparation and the ability to cope with the stress and anxiety of performance may well be the deciding factors between personal success and failure, between staying in a sport and dropping out. Additionally, at the very top levels of skill, physical differences among competitors decrease and psychological components emerge as increasingly important. Specific training in the management (self-regulation) of personal psychology appears to help many athletes more effectively demonstrate their skills under pressure. This article will show 1) the relationship between stress (psychological and physiological) and performance, 2) the typical role of anxiety, and 3) ways of psychological coping that have proven helpful to many athletes to achieve the "fine-tuning" effect.

STRESS AND FINE-TUNING

Stress is the body's response to psychologically perceived events. Athletes react to many things in their environment (physical, social, psychological) called "stressors." These include such things as watching rivals warm-up, having parents or psychologically significant persons in the audience, listening to scores of other swimmers and reactions to their own mistakes. Some athletes let such concerns worry them to the point of interferring with performance; they often do less well in competition than during practice. Other swimmers try to ignore such distractions or may not be bothered by them. A few swimmers actually use such stressors as motivators to perform well beyond what would be expected, and in rare instances, may perform in that super, spine tingling, unforgettable way. The stress response, then, is basically a person's psychological and physiological reactions interacting with each other in either a helpful or harmful way. The typical relationship between stress and synchronized swimming performance is shown in Figure 1.

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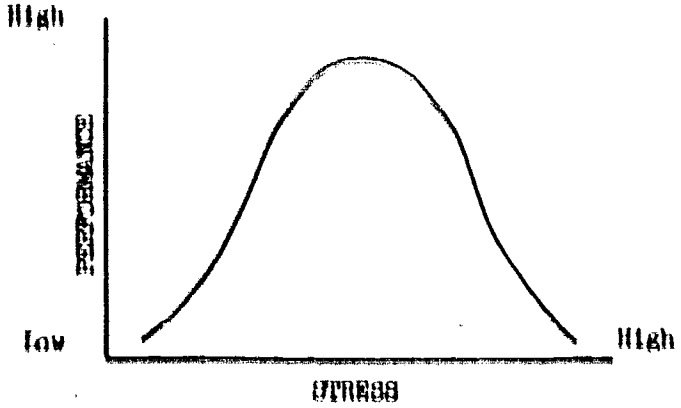

Figure 1. Performance tends to increase as stress increases to an optimal point. Performance decreases with too much stress.

As you can see, optimal stress is an important ingredient in performance excellence. A healthy level of stress heightens alertness and readiness for physical and psychological action. Athletes in this state often report a sense of being highly "tuned-in" and experience feelings of moderate exitement. They appear to swim in a seemingly relaxed, yet highly responsive, fluid and controlled way, very much in tune with themselves and the audience.

Anxiety. Too much perceived stress, or poor coping with stress, however, is often accompanied by an overwhelming sense of anxiety. Family worries, a recent "blow-up" between coach and athlete, an illness of a team member, personal or family expectations poorly handled can create problems for the athlete. Anxiety responses are learned and may start early in life. Sometimes anxiety is generalized to the point where a person feels anxious all the time (trait anxiety). More often, for athletes, it is specifically linked to a given competition, particular times and/or circumstances within the competition sequence, or to specific worries and expectations the athlete has (state anxiety). It happens to everyone and we

all react both physiologically and psychologically to to anxiety arousing situations. What triggers anxiety (negative stressors), however, may differ for each person facing a similar situation. For example:

> Two swimmers are vying for the one open spot in the team routine. The choice will be made following a figure skills competition the next weekend. Swimmer #1 very much wants to make the team. She fervently hopes a figure she has trouble with (castle) will not be drawn at the meet. Swimmer #2 is very ambivalent about making the team. She is worried that she is not good enough to swim the team routine and may let her team members down. Not making the team will be a deep personal disappointment to her and her family.

From this description, each swimmer is likely to respond anxiously at the meet, but for different reasons. Figure 2 illustrates what may happen when severe anxiety affects the athlete:

Negative stressors
(ambivalence, personal worries, physical conditions, etc.)

Feelings of Psychological Threat
(something dire may happen)

Internal Mind-Body Tension
(homeostatic imbalance, psychological disequilibrium)

ANXIETY

Possible Psychological Responses	Possible Physiological Responses
fear of failure	rapid heart beat
fear of success	short and rapid breathing
selective forgetfulness	rapid speech
low self-esteem	severe and generalized muscle tension
psychosocial withdrawal	

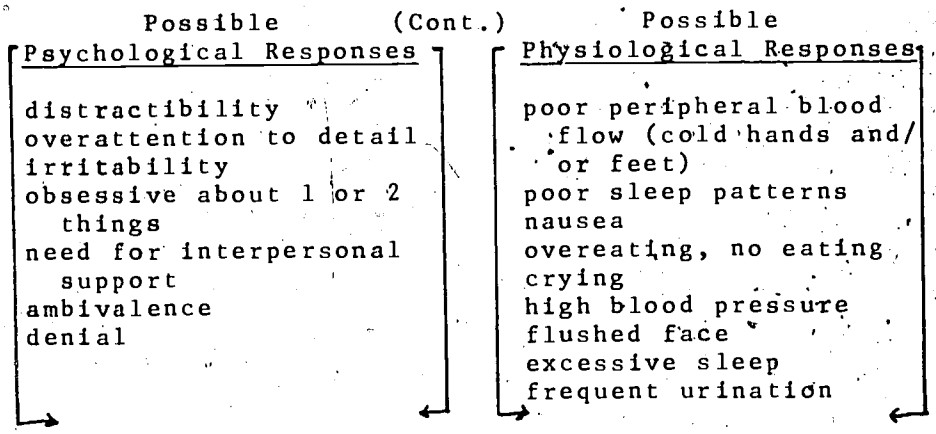

Figure 2. Effects of Negative Stressors

Returning to the example of the two swimmers hoping to make the team:

> Swimmer #1 works hard on her castle during practice but it does not seem to get much better. She becomes withdrawn, has a hard time getting to sleep and does not eat well. On the day of the meet, she seems pale and unapproachable. The castle is drawn as her last figure before the judges. Her heart pounds, legs cramp and she is short of breath. She gets adequate scores on her other figures, but can't stop worrying about the castle. She desperately wants someone to comfort her, but cannot tolerate the idea of anyone knowing how scared she is.
>
> Swimmer #2 becomes increasingly irritable during practice and experiences a number of dreams before the competition. At the meet, she is hyperactive and frequently interrupts those around her. She is both pleased and worried that her parents are in the audience. She frequently visits the bathroom and complains of feeling cold. She has a hard time concentrating

and sometimes appears dazed. Hugging her favorite stuffed animal is no help. On the first panel she does the wrong figure.

Self-Regulation: Mind-Body Feedback. Is it possible for individual athletes to change responses to anxiety? Many athletes can and do learn to effectively regulate their responses with training. For example, slowing down rapid rates of speech and breathing bring a sense of psychological calm. For some, elevated heart beats and muscle tension may be lowered by psychologically repeating or visualizing particular words or phrases such as "I feel relaxed, calm and in control." Others may be able to control distractibility and increase concentration by imaging the ideal or perfect performance while in a muscularly relaxed, yet alert state. Many athletes learn to enhance feelings of confidence and actual performance through such psychophysiological fine-tuning. It is not easy and requires consistent practice outside the competitive situation just like the learning of any new skill. It is the achievement of an integrated mind-body process by incorporating both internal and external awareness and feedback.

Synchronized swimmers are very familiar with the concept of feedback. They receive it during every practice and work hard to increase performance based on the information they receive. Feedback (Figure 3) usually starts at an early stage with trial and error learning. Feedback is then sought from significant others, such as coaches and teammates. The athlete gains even more detailed and refined information by actually seeing herself in action - on videotape, stop-action films, written reports, etc. The most refined and often elusive dimension of feedback is the awareness of her immediate psychological and physiological functioning: heart rate, breathing, muscle tension, hopes and expectations, worries, etc. The athlete learns to shift from almost sole reliance on information from external sources to the inclusion of internal mind-body information. The impact of this shift may initially generate its own form of tension. Nevertheless, it can be self-

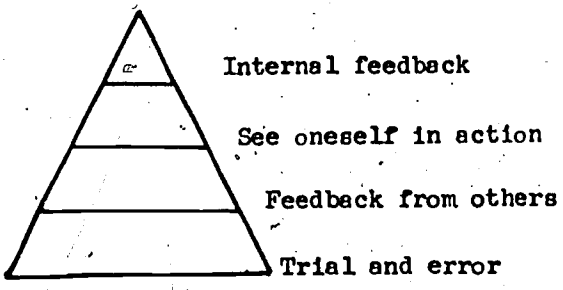

Figure 3. Fine-tuning is the increasingly refined use of different levels and forms of feedback.

monitored, controlled and changed, if need be. The ability to use all forms of feedback in a selective way is a significant key to effective self-regulation and performance excellence.

SELF-REGULATION PROCEDURES

Most self-regulation exercises are based on achieving deep muscle relaxation, regulating degrees of muscle tension-relaxation in daily life as well as athletic activities, breathing awareness, visualization and imagery, the use of self-repeated verbal phrases and the identification of specific stressors related to synchronized swimming competition. These will be described in detail later.

Coaches and athletes who have participated in self-regulation or stress management programs have found some very clever ways to adapt them to their own purposes. You may wish to try some of the exercises before involving others. It often helps coaches to first go through a program with someone who knows the techniques and who can help them design a program for their home clubs. It needs to be pointed out that not all athletes need all procedures, others may not practice them sufficiently to be able to use them in

a pressure situation, and some "do not believe in them" and choose not to participate. My colleagues and I have worked with coaches and athletes from age 10 to the internationally experienced in several sports. The results have been most gratifying and many participants have adopted individualized formats for themselves that have proven very effective.

A few cautions need to be noted. Most people find self-exploration and discovery fun and enjoyable; a very few may be too psychologically sensitive to the procedures. Therefore, no athlete should be forced to participate. Be sure to seek feedback from each swimmer about her experiences; some may require a quiet conference outside any group setting.

Although the benefits are many, athletes taking prescribed medications should receive clearance from a physician before undertaking deep relaxation. Relaxation may change the rate some medications are metabolized and dosage may need to be monitored. Interestingly, the need for most medications tends to drop with consistently practiced relaxation. Another possibility is that a person becomes so proficient she actually learns to mask pain or other symptoms that require treatment. Periodic reminders to check for symptoms may be necessary.

How does one tune in to internal awareness? How are habitual responses to stress and anxiety changed? These are considered for each of the following groups of procedures.

Identification of Stressors. A copy of a Competition Stress Inventory is attached. This was developed by Wenz and Strong (1980) to help swimmers identify the typical times and specific circumstances of excess anxiety. The athlete is asked to visually recall and experience as closely as possible the events of a typical, recent or specific competition. The participant is asked to rate the degree of stress/anxiety for each of the times/settings described. In addition, each is asked to identify the form anxiety takes in physical ways and the thoughts she has during these periods. Ritualistic behavior (stuffed

animals', favorite earrings, special procedures followed, etc.), reactions to award ceremonies and post-competition feelings are also described. Several interesting observations have been noted: waiting is almost universally a problem, some rituals may actually increase rather than decrease anxiety, sleeping well is often difficult, the need for "private" time or additional interpersonal support becomes exaggerated, and many athletes and almost half the coaches experience significant post-competition burn-out and depression.

Coaches are encouraged to meet with the athlete and share their impressions about how the athlete typically responds to the Competition Stress Inventory. This allows for clarification of differences and facilitates an individualized stress management format for the athlete as well as one for the team as a whole to incorporate as many needs as possible.*

Breathing. Breathing is literally the basis of life, yet few people breathe properly by taking a full and deep breath beginning with the diaphragm (lower rib cage and upper abdomen rise). The tendency is to fill either the upper part of the lungs (only shoulders and chest rise) or the middle chest (only the rib cage moves). There are two purposes for this exercise: awareness of personal breathing patterns and studying the relationship between breathing responses and different levels of body tension (Stroebel, 1978).

#1 Gently close your eyes (sitting or lying down) and quietly pay very close attention to your breathing. Feel the air come into the nostrils and try to sense the air moving deeply down into the lungs. Place your hand on the upper part of the abdomen (diaphragm) and notice if it moves up and down as you inhale and exhale. Do this for a few minutes by quietly and passively focusing on breathing and relaxation. If you deepen your breathing and take in considerably more oxygen than you are used to, you may feel a temporary dizziness. If this occurs, simply

*Ed. note: see Nesvig pp. 135-152

slow your breathing rate and relax quietly until the feeling passes (2-5 minutes).

Now pay attention to the slight tension in the chest and upper abdomen as you inhale and contrast this with the feeling of relaxation as you exhale. Each time you exhale, relax more and more. Notice the tension as it travels down and out of your body each time you exhale. Keep your breathing deep, slow and regular. During this period, quietly and passively direct your attention easily and effortless to various parts of your body and release any unnecessary tension (2 minutes). Now, contrast this with taking a deep breath, holding it for a few seconds and creating a high level of muscle tension throughout your body. Release the tension by relaxing your jaw as you exhale and experiencing a "rolling" muscle relaxation from the top of your body to the tips of your toes. Quietly return to slow regular and deep breathing and noticing the sense of calm and well-being that comes with it (2 minutes).

Take a few moments to practice breathing properly before practicing any of the other forms of relaxation described later (muscle relaxation, use of verbal phrases, imagery/visualization). This will help deepen the effects of these procedures more quickly and fully.

#2 Pay close attention to a deep, smooth and regular breathing pattern for a moment or two. Try to achieve a level of relaxation and quiet. With practice, this can be done very quickly. Now visualize yourself in a slightly tense situation, such as getting ready to swim before judges. Try to experience this anticipation as fully as possible. Notice how your breathing pattern changes as you begin to feel some anxiety and body tension. Return to breathing deeply and quietly.

#3 Now imagine yourself swimming a difficult routine... every stroke, every figure, every hybrid. Try to experience yourself as fully as possible as actually swimming to the music... and breathe only when you normally would during the routine. Since it is impossible to breathe normally while swimming a routine, what is your breathing pattern? Do you tend to gulp for air? Do you exhale before coming to the surface? Did you notice muscle tension beginning to build up? How can you change your breathing technique while swimming to facilitate deeper intake of air?

Muscle Relaxation. A modification of the Jacobson (1938) progressive muscle relaxation exercise is basic to illustrating the relationship between inner anxiety and muscle tension. The purpose of this exercise are to:

demonstrate the difference between muscle tension and relaxation, both physically and psychologically;

identify muscle groups that typically tighten when experiencing anxiety;

teach differential muscle tension and relaxation awareness (most people tend to tighten more muscles than are needed);

reduce lactic acid buildup in the blood due to either muscle fatigue and/or anxiety.*

Introductory illustrations could include:

Let's see how relaxed your jaw is. Relax your face as much as possible. Use one hand to open and close your jaw. Does your hand meet resistance from your jaw? Does your jaw try to "help" your hand? Can you let go of the tension in your jaw so that your hand can do all the work, and not the jaw?

*Ed. note: see Kirkendall pp. 5-15

Use only the middle finger and forefinger of one
... hand, let the fingers relax as totally as possible with no movement. Tap them with your other hand and notice how "floppy" they are when you hit them. They are easy to move and offer little resistance to being moved (a relaxed, non-responsive state).
... Now move them back and forth (with no assistance from your other hand) as rapidly and evenly as possible. Notice how responsive they are (responsive relaxation).
... Tighten both fingers as much as you can and then try to move them as rapidly as you can (tension). It is very difficult to do without loosening up the muscles. Athletes often use more muscle tension than they need.

Deep relaxation facilitates reduction of lactic acid buildup due to muscle fatigue and anxiety. It may also be used to facilitate restful sleep if practiced at bedtime. Responsive relaxation facilitates motor performance (athletics) and prevents the athlete from tightening up too much during performance. Too much inappropriate muscle tension interferes with performance and also increases the fatigue level. The following exercise is designed to teach deep muscle relaxation and will take 20-30 minutes to do properly. You may experience some tingling, a sense of floating or sinking, a "loss" of a part of your body, or a sense of watching yourself at a distance. These are normal and typical experiences and are part of the effects of deep relaxation. This exercise can be done lying down with a pillow under the head and/or knees or sitting in a comfortable chair.

Settle back as comfortably as you can. Gently close your eyes and pay close attention to your breathing (see previous exercise). Notice how it begins to slow down and becomes deeper, smoother and more regular. First, direct your attention to your left hand... clench your left fist and stud[illegible]ion in the hand and forearm. Now let go... [illegible]e the hand and arm relax. Note the difference between the tension and the relaxation. (10 second pause) Once again, clench

your left hand noticing the tensions in the hand and forearm. Study those tensions... and now let go. Note the difference once again between tension and relaxation. (10 second pause) REPEAT TWICE EACH WITH RIGHT HAND AND THEN BOTH HANDS AND FOREARMS.

Enjoy the contrast between the tension and the relaxation. Note the looseness beginning to develop. See if you can keep letting go a little bit further each time you relax a muscle. Now clench both your hands into fists and bring them toward your shoulder to tighten your biceps muscles... feel the tension and study it very closely ... and now relax. Let your arms drop and once again notice the difference the tension that was in your biceps and the relative relaxation you now feel. (10 second pause) (repeat for the biceps).

Repeat the alternating tension and relaxation twice for each of the following muscle groups. Study the tension for each muscle group and notice and enjoy the contrasting feeling of relaxation as you let go of the tension. Notice if you tense only the individual muscle group while keeping the rest of the body relaxed. After every 2-3 muscle groups, return to checking your breathing pattern.

Muscle Group	Tensing Instructions	Tension Location
shoulders	bring the shoulders upward toward the ears	shoulders and lower part of the neck
forehead	wrinkling forehead and lifting eyebrows upward	entire forehead
forehead	frowning and lowering eyebrows downward	lower forehead, between the eyes
eyes	close eyes tightly	eyelids
nose & cheeks	wrinkle your nose	nose & cheeks
jaws	tighten jaws	jaws
jaws	stretch lower jaw downward	back of jaw
tongue	press tongue against roof of mouth	area in and around tongue
lips	press lips tightly together	area around the mouth
neck	press head backward against the chair (floor, bed)	back of neck and back of scalp
neck	bend head forward and press against chest	front of neck and around jaws

Muscle Group	Tensing Instructions	Tension Location
upper back	arch back by raising stomach and chest	mainly upper back
chest	take deep breath and hold it (5 seconds)	entire chest area
stomach	push abdominal muscles outward	entire abdomen
stomach	pull stomach inward	entire abdomen
thighs	stretch both legs outward very hard	thighs
calf Right only Left only Both	hold leg(s) straight out; point toes outward and down	calf
lower front legs Right only Left only Both	hold leg(s) straight out and point toes toward your head	front of lower leg

Now review each of the individual muscle groups. As each muscle group is reviewed, notice any tension in those muscles. If there is, try to concentrate on those muscles and send messages to them to relax, to loosen. Relax the muscles in your feet, ankles and calves... shins, knees and thighs relax... buttocks and hips... loosen the muscles of your lower body ... stomach, waist and lower back relax... upper back, chest and shoulders relax... relax your upper arms, forearms and hands, right to the tips of your fingers... let go of the tension in your throat and neck... face and jaw relax... let all the muscles of your body relax. Let go of all the tension. Now rest quietly with your eyes closed. Do nothing more than that. Just sit quietly with your eyes closed. (2 minutes)

Now count backward from 5 to 1. When you reach the count of 1, open your eyes, stretch your entire body, yawn, become wide awake.

If this exercise is done in a group setting, be sure to ask participants about their experiences. Be sure to ask them what muscle groups were easiest and most difficult to relax, and what it felt like to let go of the tension. Most will experience some degree of relaxation. Others may have a concern about not being able to relax, or may experience more tension than usual in such areas as the neck and head. It may help to have them move around and do some stretching exercises. It is not unusual to have many thoughts and ideas pass through a person's mind during the initial phases of relaxation training; a few may express some concern about this. If necessary, help to meet individually with the person for a few minutes or seek consultation if necessary. By far the most common reaction is a positive one and participants tend to feel more refreshed and rested within a short time after this experience. With practice and experience, a person can achieve deep muscle relaxation in a very few minutes. Significant relaxation in a standing position can be achieved in a matter of a few seconds.

Verbal Phrases. We are all familiar with the fact that the human organism is equipped with automatic regulating systems, mechanisms and principles; heart beat, breathing, body temperature, etc. It is possible to use certain simple phrases to support or reinforce the tendency of the organism to maintain homeostasis or balance among the systems rather than let stress and anxiety upset them.* Cold hands can be warmed, heart rate lowered and breathing deepened. It was not until recently that the western world recognized that much of the autonomic (automatic) nervous system could be altered by the person through a different kind of psychological focusing than is normally experienced. IT IS IMPORTANT TO REALIZE THAT THIS IS NOT DONE BY FORCE OF WILL, BUT THROUGH THE USE OF VISUALIZATION AND IMAGINATION DURING RELAXATION. It is necessary to have a casual, detached attitude, what might be called a "creatively passive" or expectant attitude, toward the change being attempted. Simply use the phrase or word, visualize and feel that it is happening, and then simply "let it happen," so that we will not interfere with the body's tendency to cooperate.

It has been found helpful to try to visualize clearly the part of the body that is to be influenced before using the phrase relating to it. In this way, a "contact" appears to be set up with that particular part of the body. This seems to be important in starting the chain of psychological events that lead to the desired physiological changes. These changes essentially result from the psychophysiological principle which affirms that "every change in the physiological state is accompanied by an appropriate change in the mental-emotional state, conscious or unconscious, which is then accompanied by a further change in the physiological state, etc." This principle, when coupled with volition, makes possible greater mind-body cooperation and self-regulation.

*Author's note: Much of the material in this section is adapted from Green, E.F., Green, A.N. & Walters, E.D. Outline of Verbal Procedures in Developing Control of Internal States in Autogenic Feedback Training. Topeka, Kansas: Meninger Foundation

Concentrate on each phrase in whatever way seems most effective for you, repeating it verbally, or visualizing it as if you are hearing it spoken; maintain a steady flow of the phrases for the duration of the exercise. The aim is to train certain mental processes to operate in such a way that finally a very brief passive concentration on the phrase will accomplish the intended physiological change almost instantly. The use of words and phrases also help get rid of distractions and help improve concentration.

The eyes should be gently closed and quiet. Relax the body in the following manner, visualizing and feeling the relaxation of each part as you proceed. Repeat each phrase two or three times.

#1 Relaxation Phrases: "I feel quite quiet... I am beginning to feel quite relaxed... My feet feel heavy and relaxed... My ankles, my knees and my hips feel heavy, relaxed, and comfortable... My solar plexus, and the whole central portion of my body, feel relaxed and comfortable... My neck, my jaws, and my forehead feel relaxed. They feel comfortable and smooth... My whole body feels quiet, heavy, comfortable and relaxed." Continue visualizing and repeating the phrases silently for a minute or two. The phrase "I am letting go of the tension" may be added.

#2 Warmth Phrases: While you remain relaxed and quiet, with your eyes closed, visualize your hands and repeat each of the following phrases. Concentrate in a passive way, visualize the event, and then just let it happen. "I am quiet and relaxed... My arms and hands are heavy and warm... I feel quite quiet... My whole body is relaxed and my hands are warm, relaxed and warm... My hands are warm... Warmth is flowing into my hands, they are warm... warm." Continue visualizing and repeating the warmth phrases silently for a minute or two.

#3 Reverie Phrases: While you remain relaxed and quiet, with your eyes closed, repeat the following

phrases. Simply let any distracting thoughts pass through and out of your mind. Again, concentrate in a passive way visualize the event, and then just let it happen. "My whole body feels quiet, comfortable, and relaxed... My mi[illegible] quiet... I withdraw my thoughts from the s[illegible]ndings and I feel serene and still... My thoughts are turned inward and I am at ease... Deep within my mind I can visualize and experience my self as relaxed, comfortab[illegible] and still... I am alert, but in an easy, q[illegible] inward-turned way... My mind is calm and qui[illegible] feel an inward quietness." Continue us[illegible] phrases for a few minutes allowing your atte[illegible]n, your thoughts, to remain turned inward.

#4 Activation Phrases: The session is now concluded and the whole body is reactivated with a stretch and deep breath and the phrases: "I feel life and energy flowing through my legs, hips, solar plexus, chest, arms and hands, neck, head, and face... The energy makes me feel light and alive."

#5 Competition Phrases: Immediately before performing, take a deep breath and stretch the entire body. Pay close attention to a deep, smooth and regular breathing pattern and repeat the following phrases: "I feel the energy flowing through my body. I feel energy flowing through my legs, and hips, solar plexus and chest, my arms and hands, neck, head and face. I feel very light, alive and alert. I feel my body growing very tall, relaxed and confident." This may be done in a few seconds as skill is developed.

Visualization and Imagery. Various forms of visualization and imaging provide an important part of the fine-tuning process. The eyes are gently closed and quiet. The body is as relaxed as possible. Visual pictures of events or scenes are brought into focus as seen through the mind's eye. These scenes are experienced as fully as possible. It is again necessary to have a relaxed, casual and detached attitude... what might be called "creatively passive." Simply bring the picture into your mind, feel that

it is really happening and "let it happen." If distracting thoughts come to mind, simply let them pass through and out of your mind... let them go and return to the scene of your focus.

#1 General Relaxation: (This exercise is designed to reduce muscle and body tension and create a state of psychological relaxation. It is also helpful before going to sleep.) Bring to mind a very pleasant and relaxing scene.... something you thoroughly enjoy. It may be a mountain or ocean scene, a favorite activity, something distinctly pleasurable and relaxing for you. The scene may change, but always to something pleasant and relaxing. Notice how relaxed and at ease you feel, with a sense of calm and serenity. You feel very relaxed and at peace with yourself. If a distracting thought comes to mind, simply let it go and return to visualizing something pleasant. Notice any colors, breezes, texture of materials around you and experience everything to the fullest.

#2 Body Warmth: (This exercise is to develop body warmth in a cold atmosphere or when feeling anxious). Bring to mind something very warm and pleasant. It may be a fireplace, being around good friends, a sunny and warm place, a sauna. The scene may change but always to something warm and pleasant. Experience the sensation of warmth, letting it spread out to your arms and legs, hands and feet. Feel very warm and pleasant, relaxed and serene. Your entire body feels warm and relaxed. Simply let any distracting thoughts pass through your mind and return to experience a sense of warmth, ease and comfort. Notice how relaxed and warm you feel. Notice any colors around you and experience everything in the scene to the fullest.

#3 Muscle Relaxation: (This can be achieved through general relaxation imagery, described above, or by visualizing the various muscle groups as you go through the tension-relaxation exercise described earlier).

#4 Mental Rehearsal. (Suinn (1972) developed the visuo-motor behavior rehearsal (VMBR) form of visualization to increase motor performance. This technique can be used to mentally practice a single figure, a complex routine or to correct consistent mistakes. It is important to experience actually doing the movement as much as possible while in a muscularly relaxed state. There is a tendency to mentally rehearse a performance as if seeing oneself at a distance or on film. The more the person is able to actually experience carrying out the behavior, the greater the value of the rehearsal. It can be done in slow motion, especially for learning a new skill or correcting mistakes, or at normal speed).

Begin by getting as relaxed as possible with your eyes gently closed. Pay attention to deep, smooth and regular breathing and ask each muscle group in your body to relax. As you get ready to mentally rehearse a specific movement, notice a very slight surface tension on various parts of your body. Instead of feeling very heavy, you begin to feel relaxed and alert. Since you are "in the water," notice the water temperature, the size of the pool, lane markers, pool sides and try to sense as much as possible actually being in the water. Now very slowly and carefully go through a figure (e.g., ballet leg) and sense every single move your body makes as you go through and complete each movement. Notice what muscles you are using, how you are using them and the flow of muscle activity as you go from one movement to the next. Notice how you are using the water to help you, how you are using your sculling technique to achieve height and control of the figure. Notice whether you are moving through the water or staying in one spot. Pay very close attention to every detail and move within your performance.

The next rehearsal is done at normal speed. When mentally rehearsing a routine, the swimmer should also try to "hear" the music. It is important to experience the location of, and distance from, every other swimmer in the water for duet and team routines

As soon as an error is noticed during mental rehearsal, immediately go back, correct it and go on to complete the series of movements. If the error is not immediately corrected, try the entire sequence again. When the problem becomes repeated, develop the proper technique in the water before returning to mental rehearsal.

#5 Building Confidence: (This is similar to the VMBR described above. The swimmer images herself swimming an ideal performance with confidence). Go through your entire performance from the time you walk on deck to the finish of the routine. Pay attention to a feeling of relaxed confidence, a sense of lightness and free flowing energy. Notice your reactions to the audience, swimmers, officials and other around you. Quickly scan your body for any tension, release it and return to the mental rehearsal. Notice anything that tends to distract you and continue to release any tension that develops.

Biofeedback. Biofeedback monitoring may be used to objectively measure certain internal psychophysiological functions associated with stress and anxiety (Brown, 1977). Biofeedback instruments may range from the simple bathroom scale to highly sophisticated electroencephalography which measures brain waves. In other words, these instruments extend all the way from the very common and practical to those requiring sophisticated technology and knowledge. The more specialized techniques need to be used and applied under very close supervision until the participants become adept in monitoring and regulating their own internal responses. Our fine-tuning model monitors muscle activity through electromyograph (EMG) readings and the extent of peripheral blood flow to the extremities by measuring finger temperature (Thermal). Thes two systems are seen as important measures of physiological components of stress. The underlying principle is that a more relaxed autonomic response allows greater blood flow to the extremities and that the level of inhibiting muscle tension can become much less. Instrumentation assists in the demonstration that muscle and blood flow responses (the autonomic

nervous system) are amenable to individual control. The athlete first becomes sensitive to bodily responses and then, after initial exposure under supervision, continues to monitor herself by using simple monitoring devices like the hand-held thermometer. There is often a need to check back with an expert for maximum utilization. In virtually all instances EMG readings are lowered when desired, and in most cases hand temperature is readily raised or at least prevented from dropping in tense situations. If you have interest in this facet of fine-tuning, please contact a local psychologist or university for resources in your area.

PUTTING IT ALL TOGETHER

It is important that athletes participating in a psychological "fine-tuning" program commit themselves to a specific and consistent practice schedule with periodic and timely review of the procedures used. The learning process involved requires practice and positive reinforcement. It must be individualized and ultimately established as an integral part of the athlete's own training program. Once the procedures most helpful to the individual are learned and become almost automatic, the less time is needed to make them work under competitive conditions. The competition stress inventory can be used to identify the times when the athlete must be able to apply these self-regulation techniques most effectively. The attached format for developing a personal practice schedule offers several options and variations in the frequency and time spent on each activity.

CONCLUSIONS

Most athletes find that they can quite easily learn the procedures and are able to make them a part of their training program. Coaches generally are impressed with the potential of the techniques, both in actual practice and in athlete performance levels, and have shared a number of instances of increased performance in terms of anecdotal reports. Those athletes who are able to adopt the psychological procedures readily and in a consistent manner obtain

the best performance results. There is a clear shift in focus to the inclusion of internal feedback and a new sensitivity to internal functioning within the psychophysiological area. Motivational levels are raised and expectations of self are clarified and better understood. One direct benefit that has been clearly manifested is that sleep patterns are decidedly improved the night immediately before competition. In addition, the objective data gathered from biofeedback monitoring for the various groups of athletes show a decrease in electromyographic levels on muscle tension and an increase in hand temperature for peripheral blood flow in nearly all cases.

The model presented here is not without some limitations, however. Sporadic application by some athletes will give only limited results. Others may experience difficulty in transferring the techniques to actual competitive conditions. Ambivalence over one's ability and the desire to win may get in the way and limit performance. Sometimes the meaning of self-phrases varies from person to person and, therefore, the same stimulus words may not always work well for everyone. They often need to be individualized.

After considerable use, the fine-tuning model pears to have far more positive benefits than the few limitations pointed out above. The psychophysiological effects result in much greater internal motivation and control that then produce important performance differences for athletes who are relatively similar in basic capability. There is also an accompanying development of positive self-esteem in the psychological realm. Coaches who have participated with their athletes often indicated a desire for further training. It is anticipated that fine-tuning will continue to have an impact in the development of athletes as they prepare themselves for competition in the future.

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Name_____
Date_____
Sport_____
Event(s)_____

COMPETITION STRESS INVENTORY

Betty J. Wenz and Donald J. Strong

Stress Level	At Practice	Night Before	Sleep	Breakfast	Dressing Room	Warm-Up	Watching Rivals	Waiting	Figure Comp.	Waiting
10 Too High	10	10	10	10	10	10	10	10	10	10
9	9	9	9 none	9	9	9	9	9	9	9
8	8	8	8 little	8	8	8	8	8	8	8
7	7 uptight	7 nervous	7 nervous	7 nervous	7 very nervous	7 uptight	7	7	7 uptight	7 nervous
6 Moderate	6	6	6	6	6	6	6	6	6 super	6
5	5	5	5	5	5	5	5	5	5	5
4	4 good	4	4	4	4	4 good	4	4 relaxed	4	4 relaxed
3	3	3 relaxed	3	3 relaxed	3 relaxed	3	3	3	3	3
2 Low	2	2	2	2	2	2	2	2	2	2
1	1	1	1 deep	1	1	1	1	1	1	1

Instructions: This inventory is designed to be used following a visual imagery exercise where you have been asked to imagine yourself in a past or future competition. During the exercise you may have noticed particular times that you felt anxious or more stressed than you wanted. To help you more clearly identify these times, please circle the number that best represents the amount of stress you felt during the times listed at the top of each column. Do not fill in the columns that you do not need. The last column is blank so that you may list any other time during the competition that bothered you.

1 = extremely relaxed
2 = very low stress, very relaxed
3 = most daily activities with little stress
4 = good stress, such as workouts and school
5 = a relaxed and good performance
6 = a peak or super performance
7 = somewhat tight and nervous
8 = very nervous, tense
9 = feel like falling apart
10 = ill, immobilized, can't do anything

	Hear Results	Waiting	Routine Comps. 2	Hear Results	Prepare For Next Day	Routine Comps. 1	Leaving The Competition	
10	10	10	10	10	10	10	10	10
9	9	9	9	9	9	9	9	9
8	8	8	8	8	8	8	8	8
7	7	7	7	7	7	7	7	7
6	6	6	6	6	6	6	6	6
5	5	5	5	5	5	5	5	5
4	4	4	4	4	4	4	4	4
3	3	3	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2
1	1	1	1	1	1	1	1	1

Personal rituals (describe):

How do you feel after the competition? (describe):

Feelings/reactions during awards presentation (describe):

How do you typically react to too much stress and anxiety?

Name _____
Date _____
Sport _____

PERSONAL PRACTICE PROGRAM
Betty J. Wenz and Donald T. Strong

These exercises may be done while sitting or lying down. You may also wish to combine two or more formats into one exercise. Choose only those formats and time commitments that you intend to practice on a consistent basis without interfering with other activities.

1. MUSCLE RELAXATION
   - 20 minutes twice a day
   - every other day
   - other _____

2. RELAXATION WITH MUSCLE SCAN
   Even closed, quiet attentive attitude, quickly check each muscle group for any tension, and release that tension (internal muscle check). Stretch.
   - 1-5 minutes, 1-4 x daily
   - 1-5 minutes, once daily
   - other (e.g., 10 seconds before driving a car) _____

3. RELAXATION (see #2) WITH BREATHING EXERCISE
   2 minutes of relaxation with the brief muscle check; breathe in and (feel tension), breathe out (feel relaxation); breathe regularly, smoothly and deeply with relaxation. Repeat for total of 5 minutes. Stretch.
   - 5 minutes, 3 x daily
   - 5 minutes, once daily
   - other (20 each day) _____

4. RELAXATION (see #2) WITH SELF PHRASES
   2 minutes of relaxation with muscle check followed by 5 or more minutes of phrases: my arms are heavy (warm), legs are heavy (warm), my body is quiet, I am "letting go," I feel peaceful, calm and relaxed. Stretch.
   - 10 minutes, twice daily
   - 10 minutes, once daily
   - other _____

5. RELAXATION (see #2) WITH VISUALIZATION OF SOMETHING PLEASANT
   2 minutes of relaxation with muscle check, visualize something pleasant. Stretch.
   - 5-10 minutes, 2 or 3 x daily
   - 3-10 minutes, one daily
   - other (before going to sleep) _____

6. RELAXATION (see #2) WITH MENTAL REHEARSAL
   2 minutes of relaxation with muscle check; very slowly mentally rehearse some specific activity or skill; mentally rehearse at near "normal" speed. Stretch.
   - 2 x at practice, specific activity
   - 2 x at home, before practice
   - other _____

IT IS IMPORTANT TO:
1. Stretch and yawn after each exercise.
2. Try to keep out intrusive or distracting thoughts or images. When this happens, simply let them pass through your mind and focus on breathing until you are able to return to the exercise.
3. Review your practice program at least every month and make any needed changes.

PSYCHOLOGICAL ASPECTS OF ELITE WOMEN ATHLETES: SYNCHRONIZED SWIMMERS SUBSET DATA

Jerry R. May, PhD; Tracy Veach, MA;
Denise Dalley, BS and George Furman, MD
School of Medical Sciences,
University of Nevada, Reno

Presented at the Annual American
Orthopedic Society for Sports Medicine,
San Francisco, California, February, 1979

Demographics of Sample:

N (Number) = 63

Age: $\bar{x}$ (average) = 15.37 years

Range = 12-20 years

Years of Competition: $\bar{x}$ = 4.98 years

Years of Training: $\bar{x}$ = 5.12 years

Duration of Menstrual Cycle: $\bar{x}$ = 5.65 days

TABLE OF FREQUENCY AND PERCENTAGE

	N	Increase	Decrease	No Change
Effect of menstruation on training	56	0	10(15.9%)	46(82.1%)
Effect of training on menstruation flow	53	5(9.4%)	11(20.8%)	37(69.8%)
Effect of training on cycle duration	51	0	6(11.8%)	45(88.2%)
Effect of training on pre-menstrual tension	54	9(16.7%)	7(13%)	38(70.3%)
Effect of menstruation on performance	55	0	14(25.5%)	41(74.5%)
Effect of training on dating behavior	61	5(8.2%)	24(39.3%)	32(52.5%)
Effect of training on femininity	62	2(3.2%)	10(16.1%)	50(80.6%)
Effect of training on menstrual cramping	36	5(13.9%)	11(30.6%)	20(55.6%)

Effect of training on development of masculine looking muscles.	N = 60 Yes = 16(26,2%) No = 44(72,1%) Sometimes = 1 (,9%)
Attitude towards "masculine looking muscles" aspect of training.	N = 60 Positive = 32 (51,3%) Negative = 7 (11,7%) Indifferent= 21 (35,0%)

Emotional aspects of menstruation on athletic performance:

	N	%	
No effect	22	40%	
Makes "moody"	17	30.9% =	60%
Tension/irritation	8	14.5% =	Mood
Down/depressed	8	14.5% =	Changes

CONCLUSIONS

1. Most report no change in training during menstruation.
2. Most report training has little effect on menstrual cycle duration, pre-menstrual tension, etc.
3. Most report no change or a slight positive effect (i.e. decrease) of menstrual cramping from training.
4. Most report menstrual cycle does not influence performance.
5. Most report no change in dating behavior as a result of their training. However, a significant number did report a decrease in dating while training. Most felt this was due to lack of time rather than an issue of femininity.
6. Most report training did not effect their femininity.
7. Most felt their training did not cause the development of masculine looking muscles.
8. If "masculine looking" muscles did develop, most were not concerned and felt positive about their

muscle conditioning.

9. Most experienced some mood change with menstruation at times.

General conclusions of the overall study of women athletes at the Squaw Valley Olympic Training Center showed that synchronized swimmers were similar in that:

1. Female atbletes are feeling more socially accepted as women (who are feminine) and athletic.

2. Athletic competition can be a positive experience in a woman's developmental process.

ANATOMY GLOSSARY

ABDUCTION - Movement away from the middle line.
ADDUCTION - Movement of the limb toward the central axis of the body, or beyond it.
ANTERIOR - The front of body or body part.
BURSA - A closed sac lined with a synovial-like membrane and containing fluid. Bursae are found or formed in areas subject to friction.
CAPSULE - A membranous structure enveloping an organ, a joint or other part.
CLAVICLE - Collar bone.
DORSIFLEXION - Ankle movement bringing the toe toward the shin.
EVERSION - Turning the sole of the foot outward.
EXTENSION - Straightening at a joint or increasing the angle between two bones.
FEMUR - Thigh bone.
FIBULA - Small bone in lower leg.
FLEXION - Bending of a joint or decreasing the angle between two bones.
HUMERUS - Upper arm bone.
INVERSION - Turning the sole of the foot inward.
LATERAL - Away from the midline of the body; toward the sides.
LIGAMENT - A band of fibrous tissue connecting two or more bones.
MEDIAL - Toward the midline of the body.
MENISCUS - Gristle-like padding on or between bones at the joints (cartilage).
PATELLA - Knee cap.
PLANTARFLEXION - Ankle movement pointing the toe downward.
POSTERIOR - The back of body or body part.
PRONATION - Turning the palm downward.
SCAPULA - Shoulder blade.
SUPINATION - Turning the palm upward.
SYNOVIAL FLUID - A clear fluid the function of which is to serve as a lubricant in a joint, tendon or bursa.
TENDON - A band of dense, tough tissue forming the termination of a muscle and attaching the muscle to a bone.
TIBIA - Large bone of lower leg.

APPENDIX A

USEFUL SHOULDER & KNEE ANATOMY

Linda W. Daniel, BS, LPT, CAT

UPPER EXTREMITY ANATOMY

Shoulder Anatomy

The shoulder girdle is composed of two bones: the clavicle and the scapula. (Fig. 1) The humerus articulates with the shoulder girdle at the glenoid fossa of the scapula. Four joints are formed when the clavicle, scapula and humerus articulate. These joints are: the coracoclavicular, the acromioclavicular, the sternoclavicular and the glenohumeral. (Fig. 2)

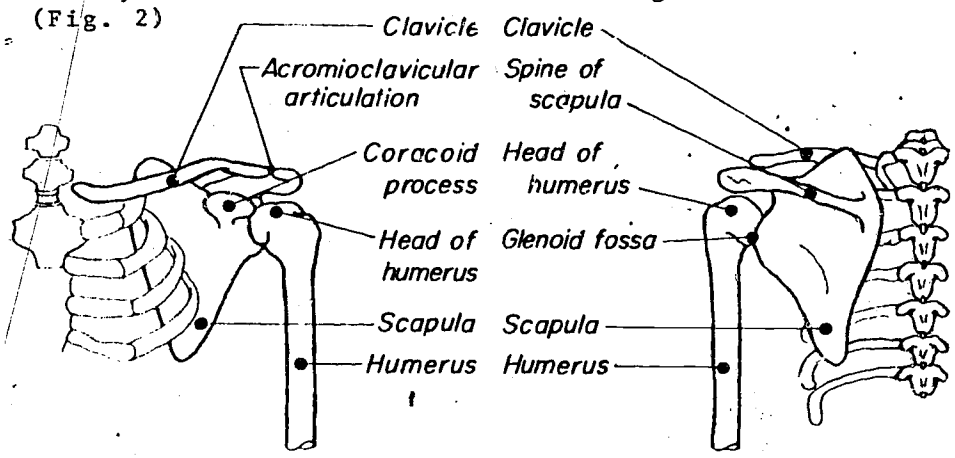

Fig. 1 Boney Anatomy of the Shoulder

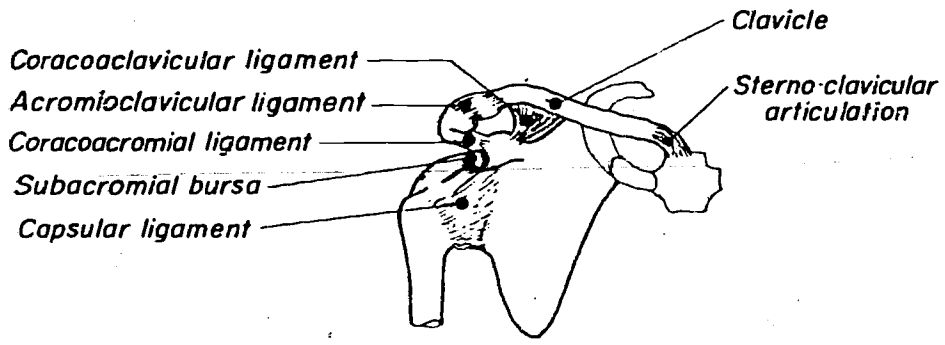

Fig. 2 Ligaments and Articulations of the Shoulder

Of the above articulations the glenohumeral joint is frequently injured while swimming. The remaining three articulations may be injured while swimming but much less frequently. Most injuries to those articulations occur during contact sports activities.

The glenohumeral joint (Fig. 1) is a ball and socket joint wherein the head of the humerus fits into the glenoid fossa of the scapula. The glenoid fossa is shallow and is deepened by a fibrocartilaginous rim. Surrounding the joint is an articulating capsule which helps hold the head of the humerus in the glenoid fossa. Glenohumeral ligaments also cross the joint to aid in stability.

Though the shoulder has numberous ligaments, the shoulder has a great freedom of movement. This can be attributed to many things, one of which is the shallow glenoid fossa. This shallowness allows the head of the humerus to move freely and permits a great range of motion at the shoulder.

Several bursae are located around the shoulder joint. Bursae are small sacs of fluid. Bursae are designed to decrease friction. The most common injured bursa in the shoulder is the subacromial (subdeltoid). (Fig. 2) Bursitis may occur in the

shoulder often due to overuse.

The muscles are the site for most shoulder injuries in swimmers. This can be attributed to the great amounts of work and forces applied to the shoulder while sculling. The muscles stabilize the shoulder and compensate for the weakness seen in the bony and ligamentous arrangement. Common muscle injuries include muscle strains and tendinitis. Therefore, it is important to understand the basic muscle arrangement and muscle functions of the shoulder.

The muscle can be grouped in to superficial and deep muscles. The superficial muscles include the pectoralis major, deltoid, teres major, and latissimus dorsi. (Fig. 3)

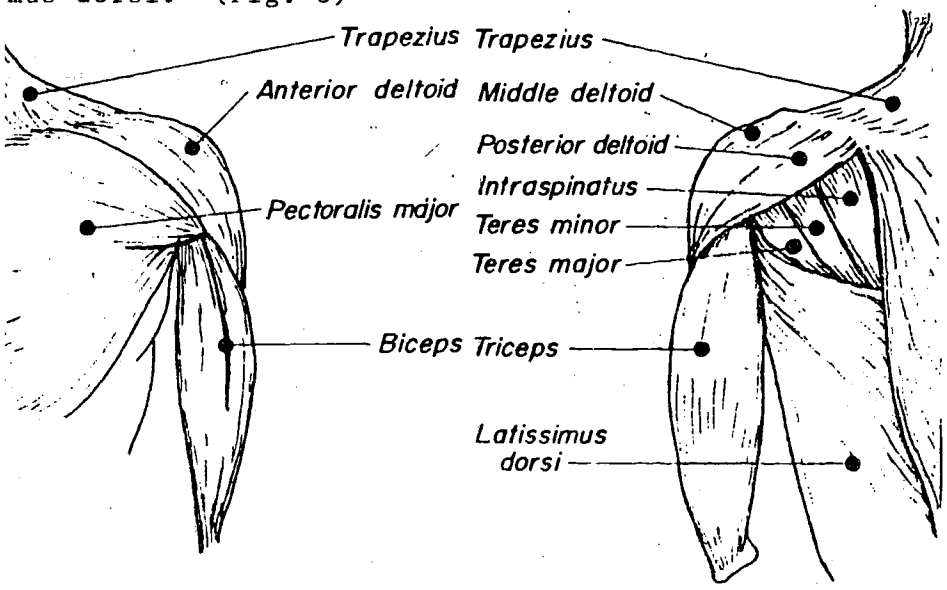

Fig.3 Superficial Muscles of the Shoulder

The supraspinatus, infraspinatus, teres minor and subscapularis compose the deep group. (Fig. 4) These four muscles are often grouped together as the rotator cuff muscles. They are frequently strained due to the extreme rotation and forces applied to the shoulder.

LOWER EXTREMITY ANATOMY

Knee Anatomy

The knee is often injured in synchronized swimming due to the stresses applied to it during the egg-beater kick. This kick can traumatize the knee unless the knee is strong and proper technique is used.

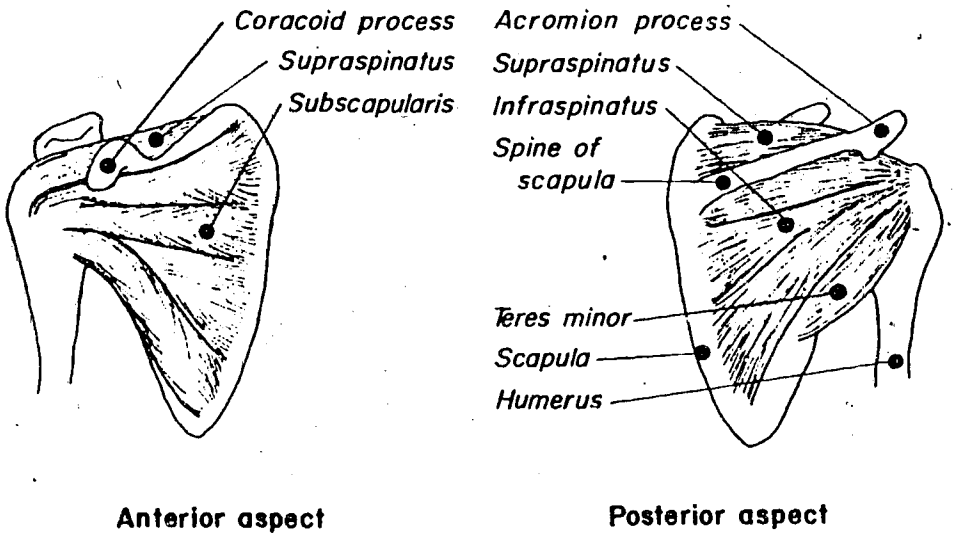

Fig. 4 Deep Muscles of the Shoulder

The knee joint is a hinge joint capable of flexion and extension. Full range of motion includes full extension (0^{o}) and greater than 90^{o} flexion. Minimal amounts of rotation is noted in the knee.

The joint is formed by the distal end of the femur articulating with the proximal end of the tibia. (Fig. 6) The patella (knee cap) sits anterior to this articulation. The knee cap is located within the quadriceps tendon and patellar ligament. The knee cap functions to protect the knee anteriorly and works to increase leverage to the knee during extension. The bony arrangement of the knee joint is very weak. Muscles and ligaments stabilize the knee and compensate for its bony weaknesses.

Medially and laterally the knee is supported by collateral ligaments. The medial (tibial) collateral ligament attaches to the medial femur and medial tibia. (Fig. 6) It is a long, wide band of ligament which supports the medial aspect of the knee. The medial collateral ligament is often sprained while kicking in synchronized swimming. The medial collateral ligament has an attachment to the medial meniscus which connects the two structures. Often when an

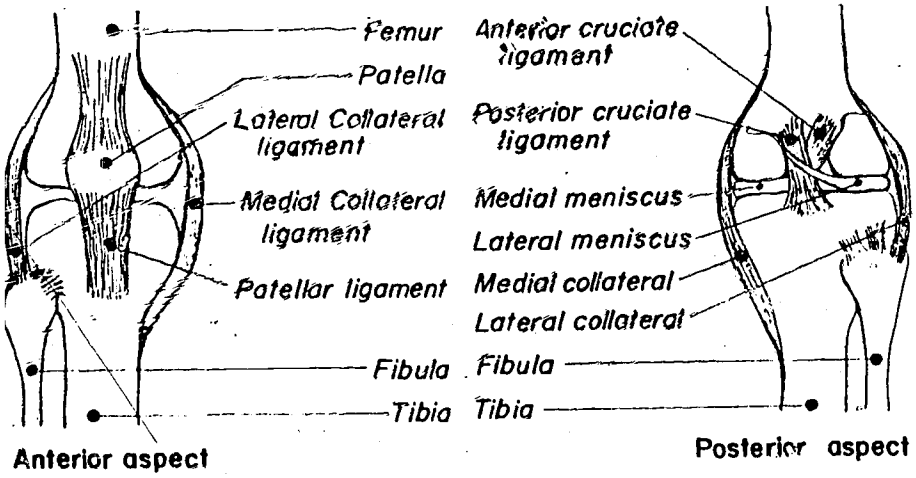

Fig. 6 Bones and Ligaments of the Knee

athlete injures the medial collateral ligament she damages the medial meniscus because of the connection between the two. The lateral (fibular) collateral ligament attaches to the lateral femur and to the lateral proximal end of the fibula and tibia. (Fig. 6) Fewer injuries are noted to the lateral collateral ligament.

There is a small amount of normal gliding anteriorly and posteriorly noted by the femur on to the tibia. The cruciate ligaments are designed to prevent excessive anterior and posterior gliding. The anterior cruciate ligament prevents posterior gliding of the femur on the tibia. The anterior cruciate ligament proceeds superiorly and posteriorly from its anterior medial tibial attachment to attach to the medial aspect of the lateral femoral condyle and the posterior cruciate arises from the back of the tibia and extends forward, upward, and inward to attach to the medial femoral condyle.* The two ligaments form and X as they cross to attach to the bones. (Fig. 6)

The menisci are two oval fibrocartilages that attach to the superior aspect of the tibia. (Fig. 6) There is a medial and a lateral menisci in each knee. They are located between the femur and tibia. They function to deepen the tibia superiorly and to absorb forces applied through the tibia and femur.

The knee joint is enclosed by a fibrous capsule. The capsule is lined with a synovial membrane which secretes synovial fluid. The synovial fluid lubricates the internal structures of the knee joint to enhance smooth movement. There are more than 18 bursae within the knee joint designed to decrease friction. Bursitis of the knee is not common in synchronized swimmers.

Extra protection and support is given to the knee by the muscles surrounding it. (Fig. 7) The anterior muscles are called the quadriceps muscle group. The four muscles in the quadriceps group are the rectus femoris, vastus lateralis, vastus medialis,

*Caillet, Rene, MD, Knee Pain and Disability

and vastus intermedialis. The quadriceps cause knee extension. Three posterior muscles are grouped together as the hamstrings. They are the biceps femoris, semimembranosis, semitendinosis. The hamstring muscle group causes knee flexion.

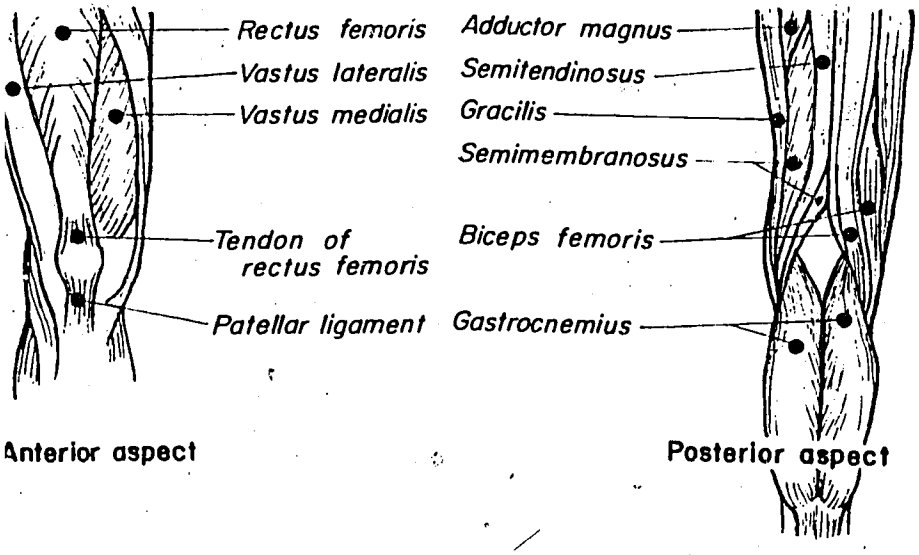

Fig. 7 Muscles of the Knee

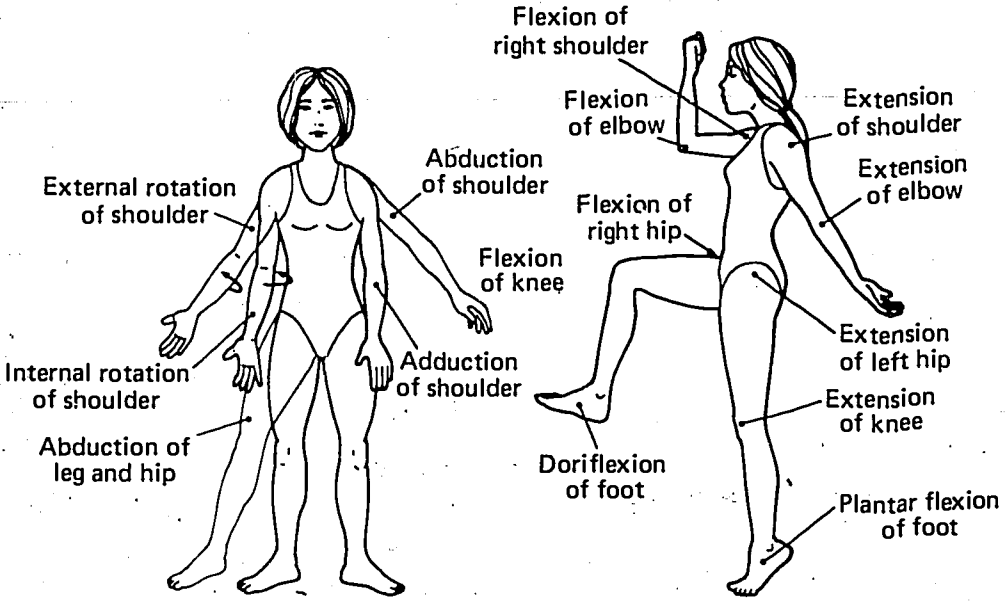
External rotation of shoulder
Abduction of shoulder
Flexion of knee
Internal rotation of shoulder
Adduction of shoulder
Abduction of leg and hip
Flexion of right shoulder
Flexion of elbow
Extension of shoulder
Extension of elbow
Flexion of right hip
Extension of left hip
Extension of knee
Doriflexion of foot
Plantar flexion of foot

FIG. 9 PRIME MOVERS*

UPPER EXTREMITY

Shoulder

FLEXION - Anterior deltoid, Coracobrachialis
EXTENSION - Posterior deltoid, Latissimus dorsi, Tere major
ABDUCTION - Middle deltoid, Supraspinatus
ADDUCTION - Pectoralis major, Latissimus dorsi
INTERNAL ROTATION - Subscapularis, Pectoralis major, Latissimus dorsi, Teres major
EXTERNAL ROTATION - Infraspinatus, Teres minor

Elbow

FLEXION - Brachialis, Biceps
EXTENSION - Triceps
SUPINATION - Biceps, Supinator
PRONATION - Pronator teres, Pronator quadratus

Wrist

FLEXION - Flexor carpi radialis, Flexor carpi ulnaris
EXTENSION - Extensor carpi radialis longus, Extensor carpi radialis brevis, Extensor carpi ulnaris

*Adapted from Hoppenfeld, Stanley. Physical Examination of the Spine and Extremities. New York, Appleton - Century - Crofts, 1976.

LOWER EXTREMITY

Hip

FLEXION - Iliopsoas
EXTENSION - Gluteus maximus
ABDUCTION - Gluteus medius
ADDUCTION - Adductor longus
INTERNAL ROTATION - Gluteus medius, Gluteus minimus
EXTERNAL ROTATION - Piriformis, Gemellus superior, Gemellus inferior, Obturator internus, Obturator externus, Quadratus femoris

Knee

FLEXION - Semimembranosis, Semitendinosis, Biceps femoris
EXTENSION - Rectus femoris, Vastus lateralis, Vastus intermedialis, Vastus medialis

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Includes a discussion of swimnastics theory and recreational swimming and describes specific swimnastics exercises (warm-up, shoulder, abdominal, waist, hip and leg, extremity, head and neck, and breathing), as well as games, contests, relays, and races. The activities are divided into beginning, intermediate, and advanced levels and are marked if especially appropriate for handicapped, geriatric, or other special groups. 1975.

ACTION IN AQUATICS

Proceedings of the CNCA 18th National Aquatic Conference in Phoenix, Ariz., with reports of five workgroup seminars and thirteen special interest groups. Topics include aquatics for the handicapped, community swimming pools, programming for pre-schoolers, synchronized swimming, kayaking, safety in camp aquatics, water polo, aquatics exercises, surfing, and lifesaving. 1974.

NEW HORIZONS IN AQUATICS

Proceedings of the 20th National Conference of the Council for National Cooperation in Aquatics. Topics covered include pool design standards (with emphasis on energy-saving techniques), aquatics for adults, scuba, life saving and accident management, underwater exercises, flotation devices, financial management of swimming pools, and swimming for the disabled and handicapped. 1979.

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THE NEW SCIENCE OF SKIN AND SCUBA DIVING (CNCA)

A standard reference and text for diving instruction, incorporating the latest developments in both teaching and technology. Contains chapters on physical and swimming ability requirements, diving skills, equipment, first aid, medical and scientific aspects of diving, environment and marine life. A project of the Council for National Cooperation in Aquatics, called by **Skin Diver Magazine** "The ultimate in skin diving texts." 4th Rev. Ed., 1974.

PRACTICAL GUIDE FOR TEACHING THE MENTALLY RETARDED TO SWIM

Designed to help professionals and volunteers teach the mentally retarded to swim or to swim better. Sections deal with the instructional staff, volunteers and aides, preservice and in-service training, and community involvement, and include creative approaches which have been used successfully in aquatics programs. 1969.

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Deals with practical application of recent research studies in synchronized swimming. Covers such topics as training methods, orthopedic considerations, psychological concerns, exercise physiology, and biomechanical aspects of figures. 1980.

SAFETY IN AQUATIC ACTIVITIES

Chapters are devoted to skin and scuba diving, springboard diving, water polo, tower diving, small craft safety, water skiing and surfboarding. Also covered are design of aquatic facilities and safety considerations in pool operation and administration. 1977.

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